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MINISTRY OF FOOD AND AGRICULTURE, DEPT. OF AGRICULTURE
GOVERNMENT OF INDIA

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PLANT PROTECTION BULLETIN

SCIENCE IN PRACTICE

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Issued by the
PLANT PROTECTION ADVISER TO THE GOVERNMENT OF INDIA
NEW DELHI

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NOTE

This Bulletin is intended to disseminate information about plant protection measures and campaigns adopted or conducted in different parts of India as well as about the advances made in the field of plant protection in other parts of the world, to the extent possible. It is also intended to give information about the latest developments in the production of pesticides, plant protection equipment and techniques of pest and plant disease control. Elaborate scientific papers on Entomology or Plant Pathology or on the chemistry of pesticides would normally not be in place in this Bulletin but short notes dealing with the behaviour or distribution of pests and plant diseases and brief notes on their epidemiology, control, etc., would be welcome.

Manuscripts submitted for publication in this Bulletin must be typed in double spacing on one side of the paper only, leaving ample margin on the left, at the bottom and on the top of the page. Photographs or drawings should be reduced to the minimum number possible and must be accompanied by a clearly typed legend which should appear under them. In addition, they should bear on their reverse in clear handwriting in pencil the name or names of the author or authors and the article which they illustrate. While this Directorate will take every care to include only such material in this Bulletin as may be considered reasonably correct and useful, it can accept no responsibility for every statement made and every opinion expressed.

Due to various unavoidable reasons, the appearance of this Bulletin has been far behind the scheduled time. While this must be greatly regretted, every effort would be made to avoid delays in future. Those who may read this Bulletin are invited to offer criticisms and suggestions for its improvement.

SARDAR SINGH,

Plant Protection Adviser to the Government of India

NEW DELHI

CONTENTS

(Vol. XIII, Nos. 1—4, 1961)

PAGE

1. Locust Situation and Control in India in 1959 and 1960
By D. V. Kohli 1

2. Control of Thrips Attacking Maize Crop
By Sardar Singh and *M. S. Guram* 4

3. Plant Quarantine at Indian Airports
By P. L. Renjhen, N. C. Joshi, Ashok Garg and *P. N. Mathur* . 7

4. Observations on the Trial of Some Common Insecticides for the Control of Paddy Stem Borer
By S. A. Ebrahim Ali and *P. N. Acharya* 13

5. Two Low Cost Hand Dusters for Plant Protection
By Y. K. Murthy 17

6. Schedule of Control of Paddy Pests and Diseases
(Contributed *by* the *Directorate of Plant Protection Quarantine & Storage, New Delhi*). 22

7. Epidemics of Rice Bug in the Northern Plains of India During the Last Decade
By S. K. Das 25

8. Control of *Gundhy* Bug of Paddy in Uttar Pradesh During 1958
By A. S. Srivastava 28

9. Rice Bug (*Leptocorisa varicornis* Fb.) Epidemic on Paddy in Assam in 1958
By K. Sundaram Pillai 30

10. Rice Bug Attack and its Control in Northern Districts of West Bengal in 1958
By S. N. Banerjee 33

11. Epidemic of *Gundhy* Bug of Paddy in Bihar in 1958
(Contributed *By B. K. Sinha, Plant Protection Officer, Bihar*) . 36

12. Campaigns Against Red Hairy Caterpillar in Madras State in 1958 and 1959
By S. A. Ebrahim Ali 38

13. Economics of Spraying with Different Types of Sprayers in Mango Groves
By B. Vasantharai David and *K. R. Nagarajan* 41

14. Diseases of Cumin Crop in Mehsana District, Gujarat State
By K. R. Bhatia 44

15. Epidemic Outbreak of Gram Caterpillar in Madhya Pradesh and Control Operations Undertaken During 1958-59
By A. L. Batra 47

16. Plant Protection in World Agriculture Fair
By B. K. Varma 50

17. A Trial on the Control of Paddy Stem Borer by Emulsion Concentrates
By S. A. Ebrahim Ali, P. N. Acharya and *N. Natarajan* . . 54

PAGE

18. Variation in the Toxicity of Benzene Hexachloride in Field
By G. N. Bhatia 59

19. Interception of *Euzophera punicaeella* Moore on Fruits of *Punica granatum* from Afghanistan
By M. K. Ponnuswami 62

20. A Serious Pest on Fruits of *Zizyphus jujuba*
By M. R. E. Khany 64

21. Interception of a Species *Macrophoma* on Imported Propagating Material of Citrus
By T. B. Lal 65

22. Control of *Acanthospermum hispidum* with Weedicides
By D. Bap Reddy 67

DESERT LOCUST SITUATION AND CONTROL IN INDIA DURING 1959—60

By

Dharm Vir Kohli,

Directorate of Plant Protection, Quarantine & Storage, New Delhi.

1959

Locust Swarms

The last desert locust (*Schistocerca gregaria* Forsk.) plague in India came to an end in 1955. The country remained free from exotic locust swarms during the subsequent 3 years. During this locust recession period the potential locust breeding areas in the Indian desert were being regularly surveyed by the permanent Central Anti-Locust Organization from about 28 permanent field locust outposts. Concentrated locust breedings were observed during 1956 and 1957 in 4 districts. The areas infested with locust hoppers as a result of this breeding were 129 and 45 square kilometres during 1956 and 1957 respectively. The locust hoppers were destroyed by dusting or spraying with insecticides and the formation of incipient swarms was thus prevented.

Early in 1959, the population of scattered adult locusts in the desert areas of India adjoining West Pakistan began to rise due to their infiltration as individual locusts from the West. During May, the increase was particularly notable practically all over the "scheduled desert area" in Rajasthan. Countless populations were recorded per square kilometre in Bikaner and Jaisalmer districts. This was followed by the incursion into India of the first exotic locust swarm from the West on 28th May. This marked the beginning of the sixth locust plague in India during the current century. A total of 24 desert locust swarms came over to India from the west in four successive waves. Their movements were reported from 433 localities in Assam, Bihar, Madhya Pradesh, Punjab, Rajasthan and Uttar Pradesh between 28 May to 16 November.

Locust Breeding

Gregarious locust breeding took place in two distinct waves. In the first wave egg laying commenced on 28th August and continued upto 10 September in Barmer district. In the second wave, egg laying continued from 12 to 24 September in Barmer, Jaisalmer and Jodhpur districts of Rajasthan. In all, egg laying occurred over a gross area of 15,232 square kilometres in 324 villages.

Control Operations

Two entire ovipositing swarms and portions of other swarms were destroyed on 11 occasions in Barmer district and on 13 occasions in Jaisalmer district by spraying with aldrin and dusting with 10% BHC.

The control operations were mainly directed against locust hoppers and all infested areas were cleared before the hoppers could reach the adult stage. Dusting with 10% BHC was the main method of killing hopper bands, although in some areas spraying with aldrin emulsion was also resorted to. In a few villages, trenches were dug by the farmers into which hopper bands were driven and killed by burying in the trenches. 1,04,000 Kg. of 10% BHC dust and 109 litres of 60% aldrin emulsion concentrate were used in the control operations.

By the end of the year, all exotic swarms and their progeny were completely destroyed as a result of which there was no westward migration of locust swarms from India.

Damage to Crops

Damage to crops was almost insignificant as the cash value of the crop reported to have been destroyed by the locusts in Uttar Pradesh was estimated to be Rs. 225/- only.

1960

Locust Swarms

The population of scattered adult locusts was low and practically insignificant during January to April. About the middle of April their number rose to 186 per square kilometre in Rajasthan. The first exotic locust swarm crossed into India in Bikaner district of Rajasthan on 14 April. In all 109 locust swarms of various stages of maturity came over to India through west Pakistan in 3 successive waves upto 15 October. Their movements were reported from Andhra Pradesh, Assam, Bihar, Gujarat, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Union Territory of Delhi, Uttar Pradesh and West Bengal during April to December.

Locust Breeding

Egg laying occurred in two distinct waves, from 3 July to 8 August in Barmer, Bikaner, Churu, Jaisalmer, Jodhpur, Jhunjhunu, Nagaur, Sikar and Sri Ganganagar districts of Rajasthan and Mohindergarh district of Punjab; and from the end of August to 6 October in Alwar, Barmer, Bikaner, Churu, Jaisalmer, Jodhpur, Jhunjhunu, Nagaur, Sikar and Sri Ganganagar districts of Rajasthan and Mohindergarh district of Punjab. The gross area infested was estimated at 97,599 square kilometres in 4,535 villages.

Control Operations

The swarms were particularly active during April to June. High temperatures and strong winds hampered their destruction. With the onset of monsoon rains during July, the swarms became less active. Portions of them were destroyed on 65 occasions in Barmer, Bikaner, Churu, Jaisalmer, Jodhpur, Nagaur, Sikar and Sri Ganganagar districts of Rajasthan.

As in previous years, main control operations were directed towards the destruction of hopper bands although egg-beds were sprayed with aldrin over 110 hectares in Bikaner and Jodhpur districts of Rajasthan. The hoppers that emerged from the sprayed areas died within 24 hours of their emergence. Generally all the infested localities were cleared before the hoppers could reach adult stage.

Dusting, spraying and trenching were the main methods of hopper control in the infested areas. The following quantities of insecticides were used for the purpose:

BHC-10% dusting powder	8,44,000 Kg.
Aldrin-60% emulsion concentrate	818 litres.

Damage to Crops

Reports of damage to crops were received from the States of Andhra Pradesh, Assam, Bihar, Gujarat, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Uttar Pradesh and West Bengal worth about Rs. 16,24,797. Keeping in view the number of States visited by the swarms, the losses were not of much consequence and in any case no land revenue remissions became necessary.

CONTROL OF THRIPS ATTACKING MAIZE CROP

By

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Thrips (*Anaphothrips flavicinctus* Karney) on maize are usually considered a minor pest. The insect scrapes the epidermis and then sucks the cell sap, as a result of which the leaves are covered over by small white patches giving a whitish appearance to the whole crop and the size of the crop is reduced. If the crop is attacked in the early stages, it almost dries up.

Prior to the introduction of DDT in India, the use of nicotine sulphate was recommended for the control of thrips in the Punjab (Rahman, 1939). Later both nicotine sulphate (1 : 1000 parts of water) and DDT 0.1% suspension at the rate of 30-50 imperial gallons per acre, were being officially recommended for the control of thrips which is also a major pest of onion in Punjab. The need was felt to search for a better insecticide. Dieldrin, aldrin and heptachlor are some of the latest insecticides to give good control of onion thrips as reported by Sloan and Rawlins (1951). Several new organic phosphate and chlorinated hydrocarbon insecticides are good for controlling onion thrips as shown by Richardson and Wene (1952) and Richardson (1953) in review of the literature on the control of thrips.

The presence in May, 1960 of the widespread infestation of the young (bunches) maize crop sown for fodder by *A. flavicincutus*, therefore, presented an opportunity for testing the efficacy of some modern insecticides like endrin, diazinon, malathion, ethyl parathion, rogor and phosdrin with 0.1% DDT suspension and nicotine sulphate as standard. Results of the two replicated field trials carried out with the above mentioned insecticides are reported below.

The two experiments were laid out in a private farm in village Dhaula near Ludhiana during the first week of May. The plot size was kept at 1/160th acre and 2-feet bund was kept between the treated plots. There were nine (two chlorinated hydrocarbons, five phosphatic, one botanical insecticide and one control) treatments (randomised block system) with four replications each at the rate of 50 gallons of spray material per acre. Spraying operations were carried out with a fine nozzled Gator rocking sprayer. Pre-treatment and 48 hours

after treatment observations were recorded on the basis of 25 plants selected at random and counting all adults and nymphs. Results are tabulated below :—

TABLE 1

Percentage mortality of thrips (*Anaphothrips flavicinctus* Karney) (average of 4 replications).

Date of trial	2-5-60	5-5-60
Date of observation	4-5-60	7-5-60

Treatment	*Experiment I*		*Experiment II*	
—	Mean	Degrees (angular transformation)	Mean	Degrees (angular transformation)
DDT 0·1% suspension	94·4	76·4	94·8	76·9
Endrin 0·01% emulsion	93·0	74·8	92·6	74·3
Diazinon 0·01% do	97·7	81·4	97·9	81·7
Malathion 0·05% do	86·0	68·0	86·0	68·0
Ethyl parathion 0·01% do	98·9	84·6	99·3	86·1
Rogor 0·01% do	97·8	81·7	97·0	80·4
Phosdrin 0·01% do	97·0	80·2	97·1	80·3
Nicotine sulphate 0·04% do	95·6	78·0	95·8	78·2
S.E.=	1·1		S.E.=	1·16
C.D. at 1%=	3·11		C.D. at 1%=	3·28
C.D. at 5%=	2·29		C.D. at 5%=	2·41

From the data of the present series of experiments it may be concluded that all the hydrocarbon and phosphatic insecticides (at the dosages used) proved effective in controlling the thrips attacking the maize crop, except malathion. Ethyl parathion/diazinon/rogor/phosdrin proved superior to others. Endrin is the cheapest of all the materials tried followed by rogor, phosdrin and ethyl parathion respectively (Table 2).

TABLE 2

Comparative cost of different Insecticides.

Insecticide	Concentration used	Quantity of technical material per acre	Formulate used	Quantity of formulate material used	Cost of pesticide of formulate material	Cost of pesticide required
1	2	3	4	5	6	7
					Rs. nP.	Rs. nP.
1. DDT	0·1%	8·0 oz.	50% W.D.P.	16 oz.	2·75	2·75
2. Endrin	0·01%	0·67 oz.	20% E.C.	4 oz.	7·50	1·87
3. Diazinon	0·01%	0·67 oz.	20% E.C.	4 oz.	10·00	2·50

1	2	3	4	5	6	7
					Rs. nP.	Rs. nP.
4. Malathion . .	0·05%	4·00 oz.	50% E.C.	8 oz.	7·00	3·50
5. Ethyl parathion .	0·01%	0·82 oz.	46·7% E.C.	1·70 oz.	22·00	2·34
6. Rogor . . .	0·01%	0·80 oz.	40% E.C.	2 oz.	16·00	2·00
7. Phosdrin . .	0·01%	0·67 oz.	20% E.C.	4 oz.	8·69	2·17
8. Nicotine sulphate .	0·04%	1·6 oz.	40% E.C.	8 oz.	7·25	3·66

In the order of efficacy, ethyl parathion ranked first, followed by diazinon, phosdrin and rogor, all giving a kill of 97 per cent or above. Considering also the economics of treatment, the use of ethyl parathion /rogor and phosdrin at the rate of 0·82, 0·80 and 0·67 oz. of technical material per acre respectively costing Rs. 2.34 nP., Rs. 2.00 and Rs. 2·17 nP. per acre is, therefore, recommended for the control of thrips attacking maize crop.

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PLANT QUARANTINE AT INDIAN AIRPORTS

By

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Introduction

In India the first step to enact legislation for preventing the introduction of pests and diseases dates back to 1914, when the Destructive Insects and Pests Act came into being; but unfortunately the objects of the Act could not be fully realised before 1949 when the first full-fledged Plant Quarantine Station was started at Bombay and since then Plant Quarantine Stations at sea ports were opened at Madras (1950), Cochin (1955), Calcutta (1956), Visakhapatnam (1957) and Kandla (1961). In view of the importance of Plant Quarantine at air ports in the present age, six Stations at the air ports of Bombay (Santa Cruz), Calcutta (Dum Dum), New Delhi (Palam & Safdarjung), Madras (Meenambakum) and Amritsar (Rajsansi) were opened by the Government of India. The airports of Bombay, Calcutta, Madras and New Delhi are the recognised international ports for the import of plants by air, whereas the station at Amritsar was established mainly to facilitate the import of fruits from Afghanistan and other countries. The list of plants and plant materials received at different airports in India and the number of international aircraft attended for baggage inspection during the last four years is given in Tables 1 and 2.

Inspection of Plants and Plant Materials

In case of plant imports, the Customs Department is the agency through which the plants and plant materials are received at the Plant Quarantine Stations. Alongwith the permit, an orange and green colour tag is issued by the Plant Protection Adviser, which the exporters are to paste on the packing case or container of plants or plant material. It helps the customs to distinguish it from other packages. Such consignments are promptly sent to the Quarantine Stations. Passengers who bring plants or plant materials as accompanied baggages, are diverted to special quarantine counters. As soon as the consignments are received, the weight/number is recorded and proper receipts are issued stating as to whether the parcel is detained for want of documents or will be released after necessary treatment etc., alongwith the probable date and time of release. The inspection depends upon the nature of plant materials. At the time of inspection the plants are thoroughly examined by well trained staff posted at air ports and after inspection the consignment is suitably treated in order to kill the insects and fruiting bodies of the fungus diseases and other disease causing organisms. The biological aspect involved in the inspection is that there are certain

diseases which may not show their symptoms at the time of export but during transportation their incubation period may be completed and thereby may develop obvious symptoms. Apart from this, there are certain other diseases which are symptomless in mother plants. For example, the tomato spotted wilt virus in Dahlia corms may not show any symptoms but if they are grown under quarantine and insect vectors fed on them and later on tomato, the tomato plants may reveal the presence of this disease. In the same way the yellow virus on sweet cherry or plum stocks may not show any symptoms but it can be detected by budding on peach seedlings which develop symptoms on artificial inoculations.

The plants at the time of inspection, if suspected for such diseases, are kept in the segregation house (*i.e.*, glass house) provided or are being provided in all major Plant Quarantine Stations in India.

Inspection of international aircraft is an important part of the plant quarantine and at various airports such inspections are also carried on, depending on the facilities given by the Civil Aviation and Airlines authorities. At some airports, as in Calcutta and Bombay, the health department is being assisted by the plant quarantine staff for inspection of the aircraft and collection of insects.

Treatment of Plants/Plant Materials

When the above formalities regarding inspection are over, the consignment, if considered necessary, is given disinfestation treatment. The prevalent treatment is fumigation. This is generally done by methyl bromide in chambers especially made of different capacities, provided at different airports. The common dosage of the fumigant is 2 lb. per 1,000 cubic feet of space for 1 to 2 hours. For cotton and tobacco. it is increased to 3 to 4 lb. per thousand cubic feet and the time of exposure may also be increased. When bulbs, cotton or tobacco samples or things of similar nature are received, vacuum fumigation is resorted to. The exposure required for vacuum fumigation is about one tenth the time required for atmospheric fumigation. The former is carried on, in special chambers (*i.e.* 10 cubic feet, 100 cubic feet and 350 cubic feet etc.) fitted with electric motors. vacuum recorder and other devices required for creating and maintaining a vacuum. Vacuum fumigation ensures deeper penetration of the gas into the material.

In case of certain commodities such as *Chrysanthemum* plants, which are susceptible to methyl bromide fumigation, other methods are adopted to, *i.e.*. treating them with a week solution 0·03% to 0·04% parathion or dusting with BHC (5% to 10%). Such treatment is also resorted to in case of tender flowers, which are likely to be affected by methyl bromide fumigation. There is no hard and fast rule that each and every consignment should be fumigated but it depends upon the individual consignment, its nature and the decision arrived at, after detailed inspection.

If imported plants or plant materials are found to be infected with diseases, various types of treatment with fungicides are given. As a rule soil should not be brought along with the plants but if it comes, it should be carefully removed, properly treated and then discarded. Following are some of the treatments employed at our Plant Quarantine Stations in India :—

(1) *Copper fungicide treatment.*—As copper is corrosive in nature, it is used for hard plant parts as twigs with barks *i.e.,* rose twigs, etc. The strength of the solution generally employed is 3% in aqueous solution. After treatment, the plants should be thoroughly washed in water.

(2) *Mercuric chloride dip.*—Mercuric chloride is a good surface steriliser but it is used for harder plant materials like bulbs, tubers and seeds, which should then be thoroughly washed with water. It is used in an aqueous solution of 1:1000 strength. It is advisable to prepare it fresh every time before use.

(3) *Sulphur treatment.*—A solution of lime and sulphur in aqueous state in the proportion of (1 part lime, 2 part sulphur and 1 part water) diluted to 8-10 times is also used as a dip or spray for woody plants. If foliage is required to be treated, the dilution should be 1-40. The solution is neither corrosive nor poisonous and can be stored in any container.

(4) *Application of dry heat.*—Plants and plant materials can also be made free from injurious diseases by keeping them in hot air oven at a temperature of 212°F for an hour, but in this case also the duration will vary with the nature of the material. In some substances, the air penetrates easily while in others it may not penetrate with the same ease.

(5) *Hot water treatment.*—Broadly speaking, dipping of plants and their parts in water at 110-120°F for a period of ten minutes to one hour is sufficient for eliminating infectious organisms. The duration of the exposure greatly depends on the nature of the organism and plant material, which should be first ascertained before treatment.

(6) *Steam pressure sterilisation.*—Sterilisation with steam under pressure kills all organisms. An exposure of 20 lb. pressure for ten minutes is sufficient for loose materials but in the case of soil, a longer period of 1-2 hours is necessary, depending upon the texture of the soil.

(7) *Treatment with Organic fungicides.*—Seeds of wheat, barley, paddy, oat, jowar, millets, maize and cotton are required to be treated with organo-mercuric compounds like Agrosan-GN, Ceresan, Tillex etc. The seeds are treated at the rate of 3 oz. of chemical per 82 lb of seeds in either power driven machine or hand driven drum. At the Plant Quarantine Stations power driven machines are available which give about 45 revolutions in a minute. The seeds should be revolved for about 5 minutes.

(8) *Treatment with other Miscellaneous chemicals.*—Formaldehyde is sometime used in the proportion of 1 part to 240 parts of water for 1 to 1½ hours dip. It has been found effective for gladiolus smut (*Urocystis gladioli*) and other diseases like basal rot of bulbs (*Fusarium bulbigenum*). It is also effective against nematode (*Tylenchus dipsaci*). As the fumes, if inhaled for a longer period, are harmful it should be used in a well ventilated room.

Sulphuric acid (concentrated) has been employed to control, in the case of cotton seeds, surface-borne organisms such as (*Xanthomonas malvacearum*) and anthracnose (*Glomerella gossypii*).

Fumigation Fees

At the airports, where plant quarantine work is done, no charges are leviable for the fumigation of consignments below 6 cubic feet in size. A fumigation fee of Rupees five is charged for every consignment of size of 6 to 12 cubic feet, and similar amounts for every additional 6 cubic feet or part thereof. Research institutions under the Central or State Governments are exempted from payment of fumigation fees.

Packing Materials

All the provisions referring to plants and plant materials also apply to all packing materials used in packing or wrapping such plants and plant materials.

Liability for Deterioration and Damage of Plants and Plant Materials

The Plant Quarantine Stations accept no liability, whatsoever, for deterioration or damage caused to any consignment of plants or any loss to the consignee as a result of :—

1. The consignment lying at the airport between arrival and inspection and treatment.
2. Inspection and fumigation or any other method of disinfection employed.
3. Delay in release of the consignment after inspection and treatment.
4. The destruction of the consignment.

Plant Quarantine Problems at Airports

Airports are situated away from the towns, so the enforcement of the plant quarantine regulations involves some peculiar difficulties. It has been observed that quite a good number of air passengers bring with them some fruits, vegetables, flowers and at times, plants too. Sometimes, such consignments are not accompanied by phytosanitary certificates nor are they covered by any import permit. Naturally, therefore, such consignments are detained or released after proper disinfestation, which takes time and passengers are requested to collect them later. This naturally annoys them, as coming again to

such a long distance is quite an inconvenient task, particularly in big cities like Calcutta, Bombay and Delhi. However, attempts are made to solve this difficulty by releasing the consignment to the respective Airlines, from whom the persons concerned take the delivery at the city booking offices. At present, at least in Calcutta airport it is being done for some consignments.

Further, it has been commonly observed that the passengers bring fruits, vegetables, flowers and some ornamental plants as accompanied baggage, which they either purchase or may belong to the gardens of their own. No phytosanitary certificates are generally available with them firstly because some of them are unaware of the plant quarantine regulations or they prefer to undergo some botheration at the destination instead of taking the material to the Government agency there for the issue of the necessary phytosanitary certificates. As an example, it may be mentioned that a vast number of air passengers from Dacca (Pakistan) to Calcutta bring with them bananas, irrespective of the fact that bananas are available in West Bengal in plenty. The reason given by them is that the bananas of Munshigang in East Pakistan are very delicious and so it is a good article for gift to their relations or friends. For similar reasons, people coming from Rangoon bring mangosteens, a fruit found only in the south India.

In view of these facts, though plant quarantine measures are adopted for extermination of the pests and plant diseases, sometimes they are considered to be irksome and create some difficult problems.

TABLE 1

Total No. of international aircraft attended to for baggage inspection during 1958-60

Place	Year	No. of international aircraft attended
AMRITSAR	1958	153
	1959	152
	1960	142
BOMBAY	1958	127
	1959	511
	1960	673
CALCUTTA	1958	736
	1959	2,010
	1960	2,127
MADRAS	1958	..
	1959	156
	1960	674
NEW DELHI	1958	..
	1959	..
	1960	..

TABLE 2

Statement showing the total number of plant consignments, airfreight, accompanied baggage and others at Amritsar, Bombay, Calcutta, Madras and New Delhi Airports during 1958—1960

Place	Total No. of Consign-ments	Year	Air-freight	Accom-panied baggage	Others
AMRITSAR . . .	353	1958			
	729	1959			
	509	1960			
BOMBAY . . .	246	1958	6	240	..
	322	1959	26	288	8
	360	1960	21	321	18
CALCUTTA . . .	49	1958	14	35	..
	202	1959	18	184	..
	276	1960	19	257	..
MADRAS . . .	..	1958	..	..	..
	22	1959	..	..	..
	37	1960	..	37	..
NEW DELHI . . .	..	1958	..	..	..
	..	1959	..	..	..
	..	1960	..	..	..

OBSERVATIONS ON THE TRIAL OF SOME COMMON INSECTICIDES FOR THE CONTROL OF PADDY STEM BORER

By

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The paddy stem borer *Schoenobius incertulas* Wlk. is the most important pest of paddy, distributed throughout India. No pesticide is yet known which can control this pest completely. A fair measure of control has been achieved by repeating the application of some insecticides two or three times. Since the Station was required to arrange demonstrations of control measures in the Nachikurichi *Gram Panchayat* area (near Tiruchirapalli), this was done by using three pesticides in the form of emulsion concentrates, namely, parathion, endrin and diazinon at 6 oz, 1 lb. and 1 lb. per acre respectively. Two applications, the first one fortnight after transplanting and second at the shot blade stage were made. The timings were chosen so as to coincide with the maximum incidence of the pest. The trial was conducted on a second crop long duration paddy, known as "Kudiraival" which is one of the most susceptible varieties to this pest. Four plots A, B, C & D of 10 cents each, uniform in all respects were selected and the treatments were randomised. Japanese method of paddy cultivation was adopted with planting in lines. Initial count of the tillers affected by stem borer was taken a fortnight after transplanting just before the first spraying. Second count of the tillers affected by stem borer was taken a fortnight after the first spraying. Third count was taken at the shot blade stage of the crop. Fourth count of the chaffy white earheads due to stem borer attack was taken a fortnight after second spraying. The results are furnished in the tables 1 and 2.

The incidence of the stem borer was found to be very severe during the period immediately after transplanting *i.e.*, November, the percentage of incidence ranged from 18 to 25. There is a gradual decrease in the incidence due to chemical treatment as well as normal climatic factors as indicated by the control plot in all the four counts from 25% to 5%.

From the point of efficacy of the treatments, parathion seems to be more effective than other treatments as indicated by the lowest percentage of 2.8 chaffy earheads. From the yield point of view (table 3), endrin treated plot has given the highest yield of 3,450 lb. per acre as compared with 3,210 lb. in parathion treated plot and 2,980 lb. in diazinon treated plot as against the normal yield of 2,920 lb. in the control plot; the percentage of increased yield over the control was 18.15%, 9.93% and 2.05% respectively.

As regards economics of spraying (table 4), the cost of treatments per acre for 2 rounds at full cost of pesticides including hire charges for equipment and labour charges worked out at Rs. 23, Rs. 19.70 and Rs. 28 for endrin, parathion and diazinon respectively. There is a net profit of Rs. 61.80 per acre in the case of endrin spraying and 26.70 per acre in the case of parathion spraying while there is a loss of Rs. 18.40 per acre in the case of diazinon spraying.

Conclusion

Insecticidal treatment for the control of the paddy stem borer, though not a complete success, proves to be fairly effective if two rounds of sprayings, one a fortnight after transplanting and another at the shot blade stage, are given. Endrin and parathion compounds are found to be more effective and economical.

TABLE 1

Statement showing average percentage of incidence of the stem borer as indicated by dead hearts

Plot and treatment	Total No. of tillers examined	Stem borer affected tillers	Percentage
	First count on 12-11-59 just before 1st spraying		
A	100	25	25%
B	100	20	20%
C	100	24	24%
D	100	18	18%
	Second count on 27-11-59 a fortnight after first spraying		
A	100	15	15%
B	100	17	17%
C	100	14	14%
D	100	12	12%
	Third count on 7-1-60 just before 2nd spraying		
A	88	7	7·95%
B	100	12	12%
C	85	5	5·88%
D	92	8	8·69%

TABLE 2

Statement showing the incidence of the paddy stem borer as indicated by white chaffy ear heads

Plot and treatment	Total No. of tillers examined	Stem borer affected tillers	Percentage
A	500	14	2·8%
B	500	25	5%
C	500	15	3%
D	500	18	3·6%

Note :

Plot A . Treated with parathion at 6 oz. per acre.

Plot B . Control Plot.

Plot C . Treated with diazinon at 1 lb. per acre.

Plot D . Treated with endrin at 1 lb. per acre.

TABLE 3

Statement showing the comparative yield of grain under different treatments

Plot	Yield of paddy in lb. in 10 cents plot	Calculated yield per acre	Percentage of increase yield over the control plot
A	321 lb.	3,210 lb.	9·93%
B	292 lb.	2,920 lb.	..
C	298 lb.	2,980 lb.	2·05%
D	345 lb.	3,450 lb.	18·15%

TABLE 4

Economics of control measures

Plot	Cost of treatment per acre for 2 rounds	Increased yield of paddy per acre over the control	Value of the increased yield	Net gain per acre
	Rs.		Rs.	Rs.
A	19·70	290 lb.	46·40	26·70
B	..	..	..	..
C	28·00	60 lb.	9·60	Loss 18·40
D	23·00	530 lb.	84·80	61·80

Note I :

Plot A . Treated with parathion at 6 oz. per acre.

Plot B . Control plot.

Plot C . Treated with diazinon at 1 lb. per acre.

Plot D . Treated with endrin at 1 lb. per acre.

Note II :

1. The value of the increased yield is calculated at Rs. 20 per bag of 125 lb. of paddy.

2. The cost of treatment includes the full cost of pesticides, hire charges for equipment and labour charges for 2 rounds of spraying.

TWO LOW COST HAND DUSTERS FOR PLANT PROTECTION

By

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Directorate of Plant Protection, Quarantine and Storage, New Delhi.

1. Hand Bellows Dusters

Two low cost, hand bellows dusters have been developed in the Directorate of Plant Protection, Quarantine and Storage. These are illustrated in figures A and C. All the materials required for making these dusters are cheap and readily available in villages except probably used auto tube.

1. Wood duster (Figure A).

Materials Required:

1. Wooden handles . . .	2 Nos.—each 20 in. × 1 in. × 5/8 in.
2. Wooden side boards . .	2 Nos.—each 6 in. dia., ¾ in. thick.
3. Used rubber tube piece of a motor vehicle.	1 No.— 5 in. dia., Length 7 in. one side 4 in. other side.
4. Tin container	1 No.—1 to 2 pounds capacity tin with tight fitting lid.
5. Delivery tube made of thin sheet metal from kerosene or vegetable oil tins.	2 Nos.—I. 16-17 in. long, 5 in. dia. II. 4-5 in. long, 9/16 in. dia.
6. Metallic hinge	1 No.
7. Nails	10 doz. ½ in. size.
8. Wooden screws . . .	(a) 4 Nos.—1 in . size. (b) 10 Nos.—½ in. size.
9. Felt	One piece 3 in. square.
10. Valve suction & delivery. (Auto tubing pieces.)	2 Nos.—1 ¼ in. × 1 in.
11. Deflector (Thin metal sheet) .	1 No.—3 in. × 2 in.
12. Binding strip (Thin metal sheet)	2 Nos.—25 in. × ¾ in.

Construction

The two wood pieces of 6 in. dia. ¾ in. thick are cut to a hexagonal shape (fig. B). The corners are slightly shamfered to avoid damage to the rubber tubing fitted on it.

A round hole of ¾ in. dia. is made in each plate to serve as suction delivery holes (fig. B). After smoothening the surfaces near the holes two rubber pieces of 1¼ in. × 1 in. are cut from auto-tubing and fixed by nails, one on each hole as shown in fig. B, to

serve as suction and delivery valves. The valves are nailed only at the top because they are intended to flap and permit the entry and discharge of air.

A rubber tube piece for the bellows is cut from the auto-tube with the angles on both sides about equal. The diameter of this tubing should be 5 in. approximately. The tube is 7 in. long on the outer side and 4 in. on the inner side. The side wooden boards are introduced inside the bellows and secured by metal strips and nails. The binding metal strip of 25 in. $\times \frac{3}{4}$ in. is securely fixed round the side plate and nailed. The bellows are stretched evenly over the side boards before being nailed in place. The nails of $\frac{1}{2}$ in. size used to fasten the bellows should be about $\frac{1}{4}$ in. apart.

Two holes, one circular of 9/16 in. dia. on the side for fixing the delivery tube and the other square $1\frac{1}{2}$ in. size at the bottom to accommodate the delivery valve freely, should be made in the tin container. After soldering the delivery tube (4-5 in. long, 9/16 in. dia) to the tin, which is fixed to the side board with four $\frac{1}{2}$ in. size wooden screws. Before fixing the tin to the side board, felt packing is given around the square hole to stop leakage of dust and air. The delivery rubber valve moves freely in the square holes provided in the felt packing and tin bottom. The details of assembly may be seen in fig. B.

The two handles are connected at the front by a metallic hinge. Wooden screws $\frac{1}{2}$ in. size are used for fixing the hinge to the handles. The handles at their rear portions are smoothened. The handles are attached to the side boards by means of 1 in. size wooden screws as shown in fig. B.

The delivery tubes are made of sheet metal from kerosene or vegetable oil tins. These sheets are flattened and rolled to the required sizes (one 16-17 in. long, 4/8 in. dia. and the other 4-5 in. long, 9/16 in. dia.). The smaller one is soldered to the tin container and the longer one is fitted tightly on the smaller tube.

The deflector is cut from the tin sheet piece 3 in. $\times$ 2 in. to the shape shown in fig. The neck is rounded to fit on the delivery tube and soldered.

Operation

To load the tin container, dust is put into the tin, upto $\frac{3}{4}$th of its capacity by placing the duster on its side with the mouth of the tin facing up. After loading, the lid is tightly replaced. By holding the handles at their free ends and drawing them in and out, the dust is discharged, through the delivery pipe and dispersed outside. The discharge of the dust is regulated by controlling the movement of the handles. In order to have an even flow of the dust from the delivery pipe, the handles should be worked uniformly throughout the operation.

2. Tin Duster

Materials Required :

1. Tin container	1 No.—Length 8 in., dia. 5½ in. sheet thickness 1/16 in. approximately.
2. Wooden pieces for handles .	2 Nos.—Length 4 in., dia. 1 in.
3. Delivery pipe of thin sheet metal from kerosene or vegetable oil tin.	1 No.—Length 21 in. dia. 5/8 in.
4 'L' shape suction tube (same material as used for delivery tube).	1 No.—Length 3 in. each side, dia. 5/8 in.
5. Rubber tube piece of a motor vehicle.	1 No.—Dia. 5 in. Length 8 in.
6. Sheet metal pieces for handle supports.	4 Nos.—2 in. × 4 in.
7. Sheet metal piece for dust filler hole.	1 No.—7 in. × 1 in.

Construction

The tin container is cut in the middle into two tin cups and the lid is soldered in its position to the tin piece. The handle supports from the sheet metal pieces are prepared to the shape shown in fig. C. and wooden handles are fixed to the supports by means of 1 in. size nails. After fixing the handles the supports are soldered to the tin pieces. Two holes for accommodating the suction and delivery tubes are drilled at the bottom of one of the tin pieces. The delivery tube is introduced about 2 in. inside in one of the holes. The 'L' shaped suction tube is kept in the second hole as shown in fig. C. After keeping the tubes in proper place they are soldered to the tin cup. For filling the dust, a hole of 1½ in. dia. is made on the side of the second tin cup and the neck is soldered to accommodate the cork for closing the filler hole. The bellows rubber tube (dia. 5 in., length 8 in.) is stretched evenly over the tin pieces and secured either by tightening with a clamp or fastening a thread around it.

Operation

The duster is loaded by taking out the cork from the mouth of the filler hole and filling it with 1½ lb. dust. After filling the dust, the cork is replaced tightly. The duster is operated by gripping the two wooden handles with the hands and drawing both the tin cups simultaneously in and out. The inlet is operated by the operator with his palm, opening and closing the hole in suction and compression strokes, alternately.

Economics

The two dusters can be easily made by farmers and village carpenters. The cost of manufacture comes to Rs. 3/- approximately for each duster. On an average about 2½ lb. of dust can be delivered in an hour and the operator can dust one acre of crop in a day. (Being light and easy to operate, the work could be done even by children over 10 years in age.) These dusters can be easily acquired even by poor farmers and is very useful to apply insecticidal dusts on a small scale.

WOODEN BELLOWS DUSTER

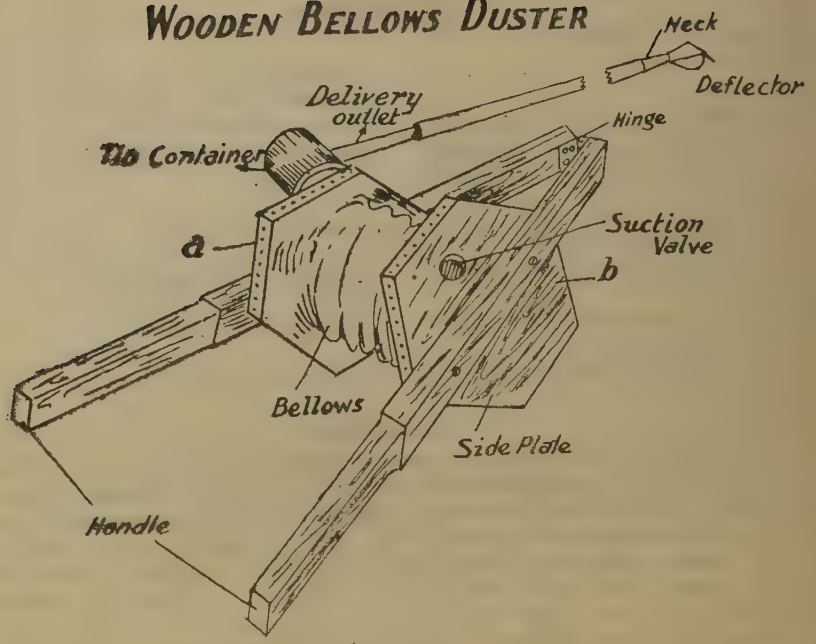
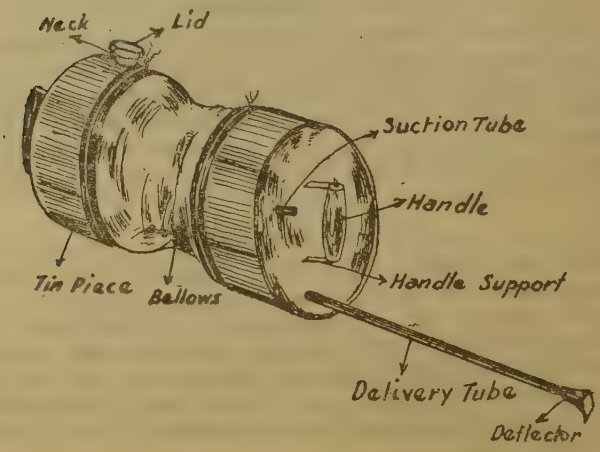


Fig. A

HAND OPERATED TIN BELLOWS DUSTER

Fig. C



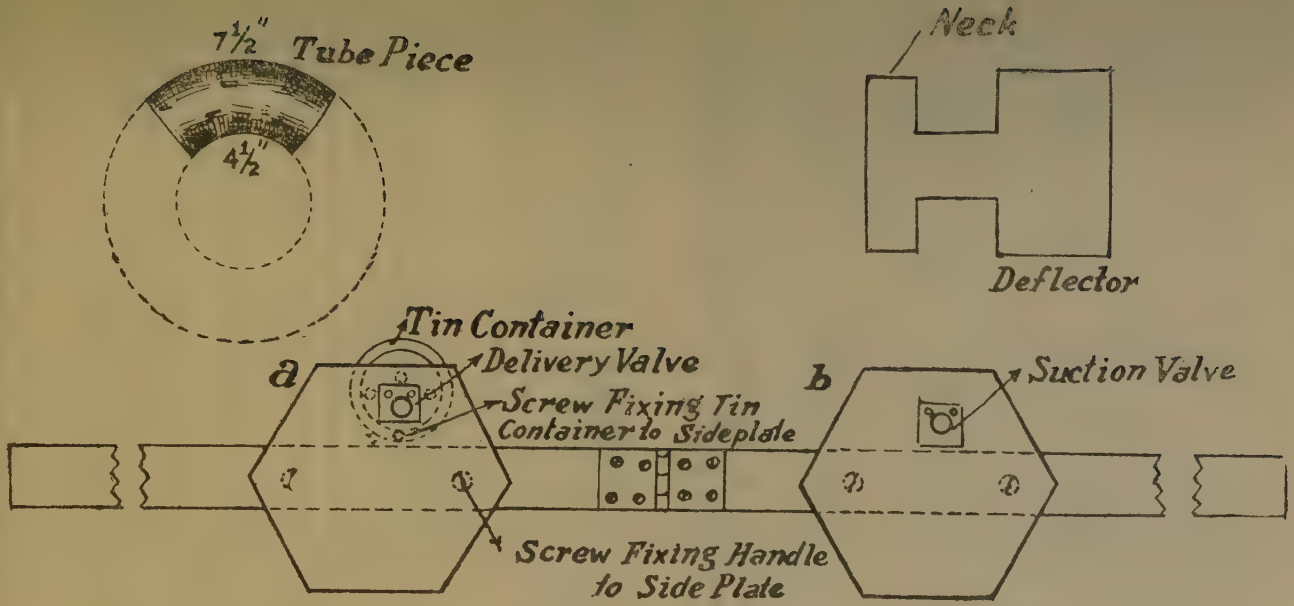

7½" Tube Piece
4½"
Neck
Deflector
Tin Container
Delivery Valve
a
Screw Fixing Tin Container to Sideplate
b
Suction Valve
Screw Fixing Handle to Side Plate

Fig. B

SCHEDULE OF CONTROL OF PADDY PESTS AND DISEASES

[Contributed by the *Directorate of Plant Protection, Quarantine & Storage, New Delhi.*]

The information on the control measures to be adopted against pests and diseases of paddy are available in many Indian publications. In all these greater stress is laid on individual pests and diseases and not on the complete sequence of treatment to be followed—right from seeds to various stages of development of crop and finally the storage of harvested produce. On the basis of current information available from publications issued from various States, a general schedule of control measures against the major and widely prevalent pests and diseases has been drawn up by the Directorate of Plant Protection, Quarantine and Storage, New Delhi. It could be adopted by the State Plant Protection Organisations with suitable modifications to suit the local conditions.

Schedule

Seed :

Treat seed with Agrosan GN or Ceresan at the rate of 1 oz. of the fungicide to 25 lb. of seed against foot rot and *Helminthosporium* leaf spot diseases.

Soil :

(i) Do not sow or transplant in the field known to be infested previously with paddy eel worms.

(ii) Minimise root weevil damage by applying superphosphate and ammonium sulphate in the soil or dust the soil with 5% BHC before transplantation.

Seedling in the Nursery or the Field :

(i) Protect young paddy seedlings from weevils which cut plants at the base, by dusting the soil with 5% BHC.

(ii) Set up light traps against paddy gall fly or spray 0·25% DDT.

(iii) Dust 5% BHC to control rice hispa and swarming caterpillar.

(iv) Collect and destroy egg clusters of paddy stem borer moth from the leaves.

(v) Dust 5% DDT or spray 0·25% DDT to control swarming caterpillars.

(vi) Spray young seedlings in nursery with Bordeaux mixture (4:4:50) or 0·3% concentration of any other copper fungicide (50% copper) against leaf spot and blast. Clean bunds to minimise infection from grasses.

Before Transplantation :

(i) Dip seedlings in 0·1% DDT suspension to protect the plants from the attack of young caterpillars of the stem borer moth.

(ii) Clip and destroy leaf tips to check infestation by rice hispa.

After Transplantation:

(i) Dust 5% BHC or DDT or spray 0·25% DDT to control swarming caterpillars.

(ii) Dust 5% BHC against thrips appearing on new leaf sheaths.

Young Crop:

(i) Dust 5% BHC to control grasshoppers, rice hispa, blue beetle, jassids, thrips, swarming caterpillar, rice case worm and paddy leaf roller.

(ii) Spray with due precautions 0·025% parathion or 0·02% endrin to check damage principally by stem borers and mealy bugs. Thrips, jassids and hairy caterpillars will also be controlled.

(iii) Spray 0.25% DDT to control swarming caterpillar, rice case worm and paddy leaf roller (alternative to treatment by BHC dusting powder for these pests).

(iv) Dust 5% DDT or spray 0·15% DDT against green and white Jassids (alternative to treatment by parathion and endrin for these pests).

(v) Spray Bordeaux mixture (5:5:50) or 0.35% concentration of any other fungicide (50% copper) against leaf spot and blast.

Crop in Milk stage:

(i) Dust 5% BHC or spray 0·25% DDT against rice bug.

(ii) Spray 0·25% parathion or 0·02% endrin against stem borer.

Crop Nearing Maturity:

(i) Dust 5% BHC to control army worm.

(ii) Dust 5% BHC or spray 0·25% DDT against rice bug.

(iii) If stem-rot disease is noted, drain the field and allow the soil to dry before irrigating again, mark out affected plants, uproot and burn.

(iv) Destroy earheads severely affected with bunt or *Agarbatti* disease.

Mature Crop:

(i) Protect crop against rats by baiting with Zinc phosphide or Warfarin.

(ii) Organise anti-rat campaigns.

After Harvest:

(i) Plough up and destroy stubbles to kill the caterpillars of stem borer moth and as a preventive measure against eel worms.

(ii) Destroy stubbles and chaff of crop affected with blast, *Helminthosporium* leaf spot, leaf smut, or stem-rot.

Seed in Storage :

(i) Store well dried seed in clean receptacles or bags. Dust the bags lightly with 5% BHC against storage pests and spray the inner surface of the receptacles with 0·2% DDT.

(ii) Adopt anti-rat measures.

EPIDEMICS OF RICE BUG IN THE NORTHERN PLAINS OF INDIA DURING THE LAST DECADE

By

S. K. Das,

Directorate of Plant Protection, Quarantine and Storage, New Delhi.

EPIDEMIC OF 1952

The rice bug (*Leptocorisa varicornis* Fb.), also popularly known as the '*gundhy* bug' due to its characteristic foul odour, is a major pest of paddy crop in the rice growing areas of north India. Every year the pest appears in the northern plains but not in an epidemic form except in localised pockets where it can cause substantial damage. In 1952, it appeared in epidemic proportions almost simultaneously in the States of Bihar, Orissa, Madhya Pradesh, Vindhya Pradesh and eastern parts of Uttar Pradesh and in due course it involved a total area of 7 to 8 million acres (Pruthi, 1953). That year the losses ranged from 2 to 50 per cent, according to the incidence of the pest with an average of about 10 per cent, mainly on early varieties of paddy. Considerable assistance by way of pesticides, equipment and technical personnel was provided by the Directorate of Plant Protection, Quarantine and Storage, New Delhi and prompt measures taken by it and the States greatly minimised the losses. In some areas, one fixed wing aircraft was used for control operations and this was used for the first time in India on a pest other than locust.

EPIDEMIC OF 1958

The second outbreak of the rice bug in epidemic from in the northern plains of India occurred six years later in 1958. It involved a total area of about 1·5 million acres. The pest was active from June onward in major paddy growing States in north India and caused widespread damage to the standing paddy crop. The intensity of attack during this epidemic was so widespread that the plant protection organisation could not cope with the situation. In spite of all endeavour and timely control measures taken both by the centre and the States, the rice bug caused losses to the extent of 5 to 60% depending upon the intensity of attack in various localities.

The first report on the epidemic outbreak of the rice bug was received from Assam in June, 1958 and subsequently it was reported from Bihar, Uttar Pradesh, Madhya Pradesh and West Bengal. The

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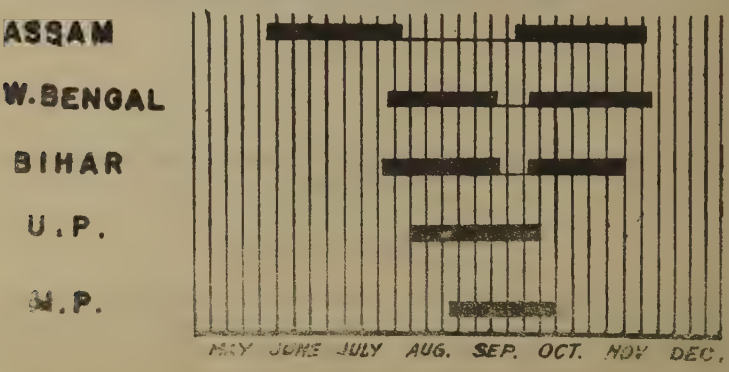
figure below will give an idea about the time of appearance and the period of activity of the rice bug in the affected States:—



According to the information received from the States a total area of about 15,08,600 acres of paddy was affected, out of which only 4,93,580 acres, including 7,000 acres treated from the air, could be treated with pesticides which was only about 32·7% of the affected area. The attention was naturally given to the areas heavily infested and even though much of the area remained untreated, the loss would not be in the same proportion. The table below will give some idea about the actual figures of both affected and treated acreage and also the percentage of treatment in respect of the five affected States:

Sl. No.	Name of the affected State	Actual area affected	Actual area treated	Percentage of infested area treated
1.	Assam	75,600	49,264	65·16
2.	West Bengal	2,50,000	2,00,000	80·00
3.	Bihar	5,93,000	1,85,900	31·34
4.	Uttar Pradesh	1,00,000	48,416	48·41
5.	Madhya Pradesh	5,00,000	10,000	2·00

Detailed accounts of the epidemic and the measures adopted to counter it in Uttar Pradesh by Srivastava, in Assam by Pillai and in West Bengal by Banerjee are being published in this issue of the journal.

During this epidemic considerable assistance by the way of pesticide, equipment and technical personnel was provided by the Directorate for assisting the States to fight out the pest. A Beaver aircraft was also utilised for aerial operations in Assam and Uttar Pradesh for the control of the rice bug; one aircraft sent to give assistance to West Bengal, crashed in Jalpaiguri and was damaged beyond repairs.

While a fairly complete picture of the epidemic of 1958 is available and control measures had been widely adopted in various States, the resultant gains occurring therefrom, have not been reported except by Banerjee, who observed that by spending Rs. 3 lakhs in control operations, crop worth Rs. 70 lakhs was saved in West Bengal. In the non-dusted area, the damage noted ranged from 10% to 60% with an average of 28% as compared to 3% in treated plots. This should clearly demonstrate the benefits of plant protection measures.

An analysis of the epidemics of 1952 and 1958 provide some interesting features. In the epidemic of 1952, the infestation was more widespread and Orissa, Vindhya Pradesh including parts of Madhya Pradesh and Bihar were worst affected. In 1958, the epidemic started from Assam on the early paddy (*Ahu* sown in March-April). It soon appeared in northern districts of West Bengal on *Aus* paddy and later, on the main crop also in the same State as also the whole of Bihar and eastern districts of Uttar Pradesh. Orissa escaped and the late appearance of the pest in northern districts of Madhya Pradesh at a time, the crop was approaching maturity caused insignificant damage.

There is no evidence that the pest is highly migratory but short immigration of the rice bug was observed in 1958. The spread of this pest into eastern and southern areas of Bihar has also been observed to occur due to immigration of the pest from the adjoining low lands of West Bengal (Sen, 1959). The factors leading to local built up of epidemic proportions of the pest have been stated by Sen (1959) and Israil & Rao (1959). Early rains leading to copious vegetation by way of grass, weeds and sowing of some early millet crops (*Eleusine corcana*) sustained rapid multiplication of the pest before the paddy crop reaches the vulnerable stage. A careful study and analysis of the prevailing agro-climatic conditions over the entire region where the epidemics of paddy bug developed in 1952 and 1958 should provide a valuable basis for forecasting its appearance in future. In such a study short migrations of the pest to provide foci for invasion of newer areas should not be lost sight of.

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CONTROL OF *GUNDHY* BUG OF PADDY IN UTTAR PRADESH DURING 1958.

By

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Plant Protection Service, Uttar Pradesh

Introduction

Paddy is one of the most important crops of Uttar Pradesh and is grown in practically all the districts of the State. The total area sown under this crop during 1958-59 in various districts was 1,01,53,501 acres. A number of insect pests attack the paddy crop and in certain years some of them assume an epidemic form, causing considerable damage to the standing crop and ultimately also reducing the yield. The *gundhy* bug, *Leptocorisa varicornis* Fb., is the most serious insect pest of paddy in Uttar Pradesh. A number of modern synthetic insecticides in various formulations, strengths and dosages were tested against this pest, as a result of which dusting with 5% BHC at 15 to 20 lb. per acre was found to be the most economic method of control.

Campaign Carried out During 1958

The *gundhy* bug appeared in a virulent form during 1958, with the result that the State Plant Protection Service, farmers and other Development Departments had to organise and conduct extensive campaigns for its control. Control operations against this pest were undertaken over about 48,416 acres of paddy fields in almost all the districts of the State.

The attack of the bug on paddy started in July and lasted till the third week of October. In all, 3.508 hand dusters, one power duster and a Beaver aeroplane loaned by the Directorate of Plant Protection, Quarantine & Storage, were employed for fighting this menace. About 374 tons of 5% BHC, 2 tons of 7% BHC, 27 tons of 10% BHC and 18 cwt. of aldrin dust were used in the control campaign, which resulted in 80 to 100% reduction in the population of the bugs. If timely action in destroying the pest had not been taken, considerable loss to the crop would have occurred.

Aerial Dusting Versus Hand Dusting

Out of a total area of about 48,416 acres of paddy crop treated against *gundhy* bug, 6,120 acres in three districts, namely, Sitapur, Sultanpur and Bara Banki, were dusted with BHC by an aeroplane provided by the Directorate of Plant Protection, Quarantine and Storage. Experience has shown that hand dusting has proved more effective in comparison with aerial dusting under local conditions. The

application of the insecticide in infested areas with hand dusting machines can be more properly regulated than in the case of aerial dusting; in the latter case there is considerable drifting of the insecticidal dust, depending upon the wind direction, to other crop fields, fallow and grassy lands. In aerial dusting the borders of the treated fields do not get an uniform distribution of the insecticide with the result that there is no appreciable reduction in the number of bugs in these areas. As the grassy and pasture lands neighbouring treated fields also get some quantity of the insecticide inadvertently during aerial dusting, the cattle refuse to graze in these areas and also refuse to feed on the fodder collected from such areas. Mechanical obstacles in the form of tall trees and in some cases poles and wires afford great hardship in low flight of an aeroplane. The absence of aerodromes near the operational areas for refuelling, landing and replenishing the stock of insecticides, is another handicap in the use of aeroplanes for fighting the menace of insect pests in the field crops.

Conclusion & Remarks

Paddy being an important crop needs utmost attention for the control of pests especially *gundhy* bug which takes the maximum toll in case it is not timely controlled. In order to get high mortality of the pest within the shortest period, only well trained personnel and recommended pesticides and machines should be used. The *gundhy* bug of paddy can be effectively controlled by dusting the crop uniformaly with 5% BHC dust at 15 to 20 lb. per acre. The dusting operation should be carried out in calm and clear weather so that insecticide may not drift away into the neighbouring fields.

RICE BUG (*LEPTOCORISA VARICORNIS* FB.) EPIDEMIC ON PADDY IN ASSAM IN 1958

By

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Gauhati.

In Assam there are three kinds of paddy namely, *Ahu, Sali* and *Boro* which are grown through out the year and provide continuous food supply to insect pests. *Ahu* is a coarse variety of paddy and is a rain fed crop. It is sown in the month of March-April with the advent of early showers which continue till July. After *Ahu* the season for *Sali*, which is the main crop of Assam, begins and the sowing starts from July. The crop remains in the field till December. In some low lying areas where there is water during the winter months and have facilities of irrigation, the cultivators try to raise a third crop which is called winter paddy. Among winter paddy, *Boro* was a new introduction in Assam during 1958. The seeds of *Boro* paddy are broadcasted in the month of November and the crop becomes ready for harvest in the month of March. Thus from the cropping pattern it appears that there is a continuous paddy growing throughout the year.

Rice Bug Outbreak in 1958

The incidence of rice bug in Assam in epidemic proportion on 3-4 months old *Ahu* paddy crop was noticed in the first week of June when the crop was in flower. The usual rains which normally start in the beginning of May, started much earlier this year and there was about 20 inches rainfall in the month of April. The rain again started in July after a prolong draught of about 2 months. This unusual distribution of rains augmented the growth of wild grasses which provided good food and shelter for rice bug in 1958.

The attack was so wide spread, that the report on the outbreak was received simultaneously from the districts of Kamrup and Nowgong. About a week later the attack of the rice bug was also reported from Goalpara and Darrang districts.

The *Sali* crop, which is sown in July-August and comes in flower in September-October, was also attacked by the rice bug. The pest might have migrated from earlier *Ahu* fields or from the hibernating places. The first report about the epidemic of the rice bug on *Sali* crop was received from Goalpara district in the last week of September. Subsequently the pest was noticed from Kamrup and Darrang districts by the middle of October. There was no attack of the rice bug on *Boro* paddy.

The exact date of reporting epidemic, the area involved and the area treated district-wise are given in Table 1.

TABLE 1

Name of District	Date of reporting epidemic		Area affected (in acres)		Area treated (in acres)	
	Ahu	*Sali*	*Ahu*	*Sali*	*Ahu*	*Sali*
Kamrup .	1st week of June.	1st week of October.	15,600	10,000	5,800	7,500
Goalpara .	2nd week of June.	Do. .	2,630	26,000	1,400	22,693
Darrang .	Do. .	2nd week of October.	3,730	4,000	1,639	1,700
Nowgong .	1st week of June.	..	13,700	..	8,532	..
		TOTAL .	35,660	40,000	17,371	31,893

It is seen from the above table that an extensive area was infested by the rice bug. The survey on the intensity of attack revealed that the infestation was very severe with an average of 15 to 20%.

Population Study

With the general idea that the attack of the pest is greatly depended on the time of planting the crop, an observation was made during this epidemic. The population study was made at Goalpara Sub-division to find out the population of the rice bug, both nymphs and adults, on the *Sali* crop. The sweeping by hand net method to determine the population, by counting the number of catch per 5 sweeps at ten different places was followed in this study. There were 70 bugs in 50 sweeps in early sown crop and 55 in the late sown crop. The difference in population on early and late sown crops, as is evident from the above table, was not very significant because the observations were taken in the month of October when the pest population was on the decline due to the advent of the cold weather.

Effects of Spraying on Rice Bug from Air

A Beaver aircraft which was sent from the Directorate of Plant Protection, Quarantine & Storage to Assam for spraying against the rice bug during July, 1958, sprayed BHC 50% W.P. on an area of about 490 acres in Hajo. To determine the effect of aerial spraying, some observations were made which are given in Table 2. Population counts were made both before and after the treatment. The exact number of insects caught with 5 sweeps are represented in Table 2, which represent one replication. There were 5 replications in all.

TABLE 2

Replication No.	Population before spraying	Population after spraying			Remarks
		30 minutes	60 minutes	120 minutes	
1	9	4	1	3	
2	10	2	2	2	
3	9	3	5	0	
4	7	4	2	1	
5	4	4	2	1	
TOTAL	39	17	12	7	

From the above table it is evident that there was a gradual reduction in the population in the treated plots. There was about 56% and 82% reduction after 30 minutes and 120 minutes after the treatment respectively. In some other observations made at Kulhati village, there was cent per cent reduction of the rice bug one hour after spraying from the air.

In addition to aerial spraying, ground operations were also organised to treat the areas where spraying from air was not possible. In this control campaign a total of about 1,10,000 lb. of 5% BHC dust, 32,400 lb. of BHC 50% W.P. and 840 lb. of DDT 50% W.P. were consumed. During *Ahu* and *Sali* seasons as many as 464 and 887 manually-operated plant protection equipment; 6 and 8 power-operated plant protection equipment were used, respectively.

It is gathered that the area under *Ahu* paddy in Assam has been progressively going down due to the attack of the paddy bug almost every year. With the introduction of modern synthetic insecticides, like BHC, it should be possible to keep the pest in check and expand the area under cultivation.

RICE BUG ATTACK AND ITS CONTROL IN NORTHERN DISTRICTS OF WEST BENGAL IN 1958

By

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Government of West Bengal, Calcutta.

It is well known that the rice bug, *Leptocorisa acuta* Thun., causes damage to the paddy crop by sucking the milk at the grain formation stage. This bug is a serious pest in West Bengal, specially in the northern districts, where it occurs more regularly in some places. But the attack in 1958 was wide-spread, severe and unprecedented when all the northern districts *viz.*, Cooch-Behar, Darjeeling, Jalpaiguri, West Dinajpur and Malda of West Bengal were affected.

Our studies on the activity of rice bug in relation to weather conditions have so far shown that the insects are active from the first week of August to middle of November on paddy.

The first invasion was noted on *aus* or *autumn* paddy in a reclaimed area of Changmari in Jalpaiguri district. This area was so long a jungle on the *char* land of river Teesta and obviously very fertile. The crop was excellent but towards the end of July, heavy bug attack was noticed by the farm staff. The total area of over one thousand acres was treated with 10% BHC dust to save the crop and the operation was quite successful.

From the study of previous years' data, a warning was issued to the Extension Staff of the Directorate of Agriculture that prevailing weather conditions were very much conductive to the multiplication of the pest. Insecticides and equipment were accordingly stored up to union level as far as possible. The activity of this bug was again noticed in the first week of October on early *aman* paddy and wild paddy which is commonly grown in defunct rivers, lakes and ponds, roadside cuttings, bogs, etc., and it was checked by the preliminary action of the local and the plant protection staff. But other wild breeding places remained undisturbed. This time we accidentally had to examine some samples of unthrashed *aus* paddy and found that grains of paddy were attacked by bugs, but the pest had escaped notice because of its mimical greenish colour or because the cultivators were preoccupied with the cultural practices on *aman* or jute crop. It was further learnt that there was a belief amongst the cultivators that the loss of *aus* paddy on an average of 4 mds. per acre each year was due to the effect of wind. So out of about 16 mds. of paddy per acre, they expect about 12 mds. and this they think normal in most cases and it is for this reason that the *aus* cultivation in North Bengal is declining.

Hot and humid weather conditions prevailed and from 15th October reports started coming again from all the northern districts of West Bengal of widespread infestation of rice bug on late *aman* paddy. The situation went beyond the control of the local staff and

all the plant protection staff from headquarter had to be mobilised. The total area affected was about 2½ lakh acres. To cope with the situation, further stocks of insecticides and equipment were rushed to the affected districts by rail, road and also by air. Altogether 2,200 hand dusters and 40 power dusters were in operation in the infected areas.

Considering the extent of area and severity of infestation, the apparently large stocks of equipment were felt to be too inadequate. So, the Plant Protection Adviser to the Government of India was contacted for further supply of ground equipment and an aeroplane for aerial dusting and spraying operations. But it was very unfortunate that we could not utilise the services of the plane as it crash landed on the very first day of its coming to Jalpaiguri. So we had to depend on ground equipment only. As the area was too vast and the time at our disposal too short for effective control of the pest, mechanical measures like bonfire, bagging and netting were also adopted. Thousands of leaflets, depicting the life history and control measures were distributed among the cultivators, so that they might solve their own problems as far as possible.

In spite of all these difficulties, we were able to control bugs over an area of 1 lakh acres with 10% BHC dust. In non-dusted areas the damage noted ranged from 10% to 60% with an average of 28%, while in the dusted areas a survey revealed a damage of 0% to 5% with an average of 3%. The saving in dusted areas (1 lakh acres) thus comes to 25% of the potential yield.

The control operations lasted from the middle of October to the first week of November. Simultaneously, survey work was also taken up. Formerly, it was our belief that bug attack in North Bengal is mainly due to migration from Bihar. There might be some migration from Bihar as northern districts of West Bengal are adjacent to that State. But the entire population is not dependent on migration only. Extensive survey was made and it was noted that the rice fields adjoining the different reserved forests were most heavily affected than areas away from them. Towards the end of my stay at the time of invasion of bugs, it was noted that when paddy crop in non-forest areas was comparatively free from bugs, they were still lingering in the adjoining forest areas on late *aman* paddy. It is worth mentioning here the peculiarity of the reserved forests in North Bengal. In addition to tall trees there are innumerable varieties of grasses. Wild paddy also grows near the border of the forests. What I think at the moment is that during the absence of cultivated paddy the bugs breed freely in the forest areas on these grasses and wild paddy and at the time of grain formation of cultivated paddy crop, they migrate to these fields. In the year of epidemic under favourable weather conditions, they create havoc to our cultivated paddy and with the onset of temporary, adverse weather conditions they migrate back to their forest abode.

A summary of the control operations with its economics is given below. I thank Dr. H. K. Nandi, Director of Agriculture, West Bengal, for the active part played by him during the control operations at a

time when all the Government Offices were closed for Puja vacation. All the supplies of insecticides and equipment from Calcutta were made under his personal supervision when the author was busy in the fields in North Bengal.

Summary of Rice bug control operations on Aman *paddy in North Bengal*

Area affected	Jalpaiguri, Cooch-Behar, West Dinajpur, Darjeeling and Malda.	About 2½ lakh acres of *aman* paddy affected.
Supplies	(a) Hand dusters	2,200
	(b) Power dusters	40
	(c) Insecticides, mostly BHC	12,000 mds. (450 tons).
	(d) Information leaflets distributed	50,000 copies.
Area tackled	(a) By chemical dusting	About 1,00,000 acres.
	(b) By Mechanical means, such as— (i) Bonfire, (ii) Bagging & netting, (iii) Dragging of Kerosenised ropes	1,00,000 acres.
Estimated savings.	(a) From chemical control @3 mds. of rice/acre *i.e.*, 25% of the average yield per acre. 3,00,000 mds. of rice @Rs. 20 per md. = Rs. 60,00,000.	
	(b) From mechanical control @1 md. of rice per acre *i.e.*, about 8·3% of the average yield per acre. 1,00,000 mds. of rice @Rs. 20 per md. = Rs. 20,00,000.	
	Total saving = 4,00,000 mds. of rice or Rs. 80,00,000.	

Estimated cost of control measure :

	Rs.
(a) Cost of Insecticides	1,70,000
(b) Transport, handling and incidentals	1,00,000
(c) Other incidentals including hire of equipments, etc.	30,000
TOTAL	3,00,000
Estimated net Savings	80,00,000
Minus estimated expenditure	3,00,000
	=77,00,000

Loss due to the insect pest:

(a) 50,000 acres which could not be tackled calculating @25% loss *i.e.*, 3 mds. of rice per acre = 1,50,000 mds. of rice.

(b) Area where only 8·3% of the yield could be saved by mechanical measures calculating @2 mds. of rice per acre of 1,00,000 acres = 2,00,000 mds. of rice.

The loss is about 2.2% of the total average yield in the affected affected areas of the Northern Range.

The loss is about 2:2% of the total average yield in the affected districts.

The estimated value of the loss @ Rs. 20·00 per md. of rice = Rs. 70,00,000.

EPIDEMIC OF *GUNDHY* BUG OF PADDY IN BIHAR IN 1958

(Information kindly provided by *Shri B. K. Sinha, Plant Protection Officer, Bihar*).

The first report outbreak of rice bug (*Leptocorisa varicornis* Fb.) was received by the Plant Protection staff in Purnea, Champaran and Saran districts on *Bhadai* paddy from 25th July, 1958 to 27th July, 1958 at various places. The area under *Bhadai* paddy in various districts was reported to be infested with *gundhy* bug and the area controlled by the State Plant Protection Organisation as well as by the cultivators themselves are as follows :—

Name of district	Reported area infested	Area controlled
	acres	acres
1. Champaran	80,000	36,000
2. Muzaffarpur	30,000	21,200
3. Saran	30,000	18,000
4. Darbhanga	6,000	3,500
5. Purnea	40,000	25,000
TOTAL	1,86,000	1,03,700

It was observed that the heavy infestation of rice bug on *Bhadai* paddy and small millets was confined to north Bihar and mostly along the border of Nepal.

A second wave of the infestation of rice bug was reported on the main crops *i.e. Katika* and early *Aghani* paddy. The first report was received (by our staff) from various places from 5th October, 1958 to 10th October, 1958 and the area reported to be infested and area controlled in various districts were as follows :—

Name of district	Reported area infested	Area controlled
	acres	acres
1. Champaran	1,00,000	12,000
2. Saran	40,000	5,500
3. Muzaffarpur	30,000	5,000
4. Darbhanga	20,000	2,000
5. Patna	50,000	21,700
6. Gaya	5,000	1,000
7. Shahabad	20,000	12,000

Name of district	Reported area infested	Area controlled
8. Ranchi	5,000	1,500
9. Dhanbad	2,000	500
10. Hazaribagh	1,000	500
11. Daltonganj	3,000	1,000
12. Chaibasa	1,000	500
13. Bhagalpur	20,000	5,000
14. Saharsa	30,000	2,500
15. Purnea	40,000	3,500
16. Dumka (S. P.)	10,000	5,000
17. Monghyr	30,000	1,000
Total	4,07,000	82,200

So far as early paddy and early *Aghani* paddy were concerned, the heavy infestation of the bug was found in almost all the districts but as the temperature went down in the last week of October, the infestation subsided.

On the receipt of the information of the severe infestation of rice bug on *Bhadai* paddy, the Government gave special sanction for giving 75% subsidy over the cost of control measures on this crop and later on the subsidy was reduced to 50% for controlling rice bug on *Katika* and early *Aghani* paddy.

CAMPAIGNS AGAINST RED HAIRY CATERPILLAR IN MADRAS STATE IN 1958 AND 1959

By

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Introduction

The red hairy caterpillar (*Amsacta albistriga,* W.) is one of the most destructive crop pest in South India and has posed quite a problem for Plant Protection workers. The caterpillars not only invade cultivated fields in countless numbers and devastate the crops, fences and avenue trees, but also cause inconvenience to human beings and livestock by encroaching into their dwellings. There has been an instance where a village school adjoining some fields had to be closed down for a number of days till the menace abated. It is a common sight in pest affected area to find the entire length of roads, completely covered with these caterpillars and appear as though a red woollen carpet has been spread over. It has been recorded that in a 2-square-feet area, the count of caterpillars was 205. On this basis the population would be 22,32,450 caterpillars per acre.

Even though the red hairy caterpillar is a polyphagus insect attacking mainly dry crops like groundnut, *jowar, bajra,* red gram, horse gram, cowpea, castor, cotton and others, it has its predilection for groundnut and the damage caused to this crop in Madras State is considerable. The entire crop is denuded of foliage leaving only a skeleton of stems and midribs. The loss may range from 20 to 100% depending upon the age and condition of the crop. Out of a total acreage of 17,50,000 acres under groundnut in Madras State, about 10% of the area lying in red soil regions is likely to be severely affected by the pest every year, unless persistant control campaigns over a period of time reduces the pest population at a low level. On the assumption that the average loss in yield in epidemic areas to be 20 per cent, the total annual loss in production could be about 17,500 tons valued at about Rs. 70,00,000.

Methods of Control

Before the advent of synthetic chemicals, mechanical methods like collection and destruction of egg masses, caterpillars and adult moths were resorted to, accompanied by trapping, by use of light and trenching round the fields to prevent migration from adjoining areas. During the early post-war years pesticides like BHC, DDT and toxaphene were tried by the Madras Agricultural Department and it was found that 10% BHC dust against young gregarious caterpillars of less than a week old and 20% toxaphene dust and BHC 50% WDP at 0.1% strength against 1-2 weeks old caterpillars gave satisfactory results. Full grown caterpillars could not be controlled by these chemicals. However, with the introduction of more potent chemicals like parathion and

endrin, the pest even in its more advanced stage of growth could be successfully controlled. Folidol 1 in 1,000 parts of water and endrin (20 per cent E.C.) 1 in 500 parts of water was found to be effective in this respect.

Factors Influencing the Control Operations

In the red soil areas the crops are not grown under irrigation. Their fate is dependent on the monsoon rains. The supply of water, therefore, is a problem for spraying pesticides. Above all, the entire area affected has to be covered as quickly as possible. Considering all these factors, control operations are undertaken mainly by dusting of 10% BHC dust which is cheap and effective; but it has its limitations in that it has to be applied at the gregarious stage *i.e.* within a week after the hatching out of the caterpillars. Light traps are used to determine the emergence of moths and to forecast the emergence of larvae. It has been found that adults emerge on the third day or so after the first heavy showers. These adults are attracted to the powerful lights. Eggs are laid in cream coloured masses on all available green vegetation in the area preferably on the lower side of leaves. A single female moth can lay 800 to 1,000 eggs. The dark coloured tiny caterpillars that hatch out in 3 or 4 days feed gregariously scrapping the leaves for next few days. This is the opportune time to take up the control campaigns. The young caterpillars seem to prefer feeding on weeds like *Croton sparsiflorus* rather than the host plant. In about 10 days the caterpillars develop an ashy brown colour and attain a length of about an inch, become voracious feeders, defoliate the entire plants and turn reddish brown with numerous hairs. Once this stage is reached, there is no use of dusting as the thick hairy covering of the caterpillars prevents the contact of the dust with their bodies. Hence spraying of parathion or endrin is the only course to be adopted.

There is yet another difficulty of repeating the remedial measures according to the emergences in a particular locality. More often the emergences take place in 2 or 3 waves after every heavy shower corresponding to the time of pupation in previous season. It may safely be said that the entire period of emergences may spread over a month and a half during which period 2 or 3 rounds of treatments may be necessary.

Control Campaigns During 1958 and 1959

During the year 1958, a total area of 12,000 acres was treated, for which assistance was also provided by the Central Plant Protection Station, Tiruchirapalli as under. The Block Development Officers of Kariapatti and Singampuneri blocks of Ramnad district and Athoor and Melur blocks of Madurai district organised control campaigns in cooperation with the Central Plant Protection Station, Tiruchirapalli for which 13 power sprayers, 3 power dusters, 43 hand sprayers and 10,000 c.c. of Folidol was provided. About 6,000 acres of groundnut were covered in these blocks and the pest was successfully controlled.

Again in 1959, about 28,000 acres were treated, of which 15,000 acres were with the assistance of Tiruchirapalli Station as under. The Block Development Officers of Athoor, Singampuneri, Srivilliputtur,

Avinashi, Gobichettipalayam blocks and District Agricultural Officer, Coimbatore organised similar compaigns for which the Station supplied 9 power dusters, 6 power sprayers, 53 hand dusters, 12 hand sprayers, 30,000 cc of Folidol and 4 tons of 10% BHC.

In 1958, duration of the outbreak lasted for about 2 months from September to November. In Pollachi taluk of Coimbatore district, the outbreak started early in the season *i.e.*, in April and ended by May. In 1959, the incidence in general took place a bit earlier as rains were received early.

The Madras Agricultural Department stocked sufficient quantities of pesticides to meet the demand and supplied them at half cost. Manually operated equipment was supplied free. In selected areas pesticides were also issued free for demonstration purpose. The general response from farmers was good and they fully cooperated with the officials in the campaigns. The success of campaigns was largely due to preparatory work undertaken much before the pest appeared, not only for stocking pesticides and equipment but also by explaining the life history of the pest to cultivators, forming control campaign squads under the leadership of progressive cultivators and *Gram Sevaks* etc.

ECONOMICS OF SPRAYING WITH DIFFERENT TYPES OF SPRAYERS IN MANGO GROVES

By

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Mango, popularly known as "Poor man's apple" in South India, is subject to the attack of many pests and diseases, of which the mango hoppers (*Idiocerus* spp.) and the powdery mildew (*Oidium mangiferae*) are the most serious. They appear during the blooming season *i.e.* December-February and cause severe shedding of flowers which ultimately result in very poor fruit set. Spraying of DDT 50% WP. and wettable sulphur one week before the opening of the flowers has been found to give appreciable relief from the pest and disease and thereby results in many fold increase in the yield. The cost of applying the materials varies from time to time and with the equipment used. A short account of the economics of the control measures adopted is furnished in this note.

The spraying was carried out in the orchards in Periyakulam and Madurai taluks with trees of about 10 years of age with an average height of 20 feet. One pound each of DDT 50% WP. and wettable sulphur were mixed in 30 gallons of water and sprayed. The labour, chemicals used, number of trees sprayed, etc. with different sprayers are detailed below.

I. Power Sprayer

Hatsuta power sprayer (2½ HP.) fitted with two rubber hoses of each 60 feet length was used in spraying. In view of the difficulty encountered in pulling the power sprayer mounted on a trolly, it was put on an open bullock cart, since there was ample space for the movement of the cart in the grove, and then operated. For carrying out the operation four men (*i.e.*, one for driving the cart, one for operating the sprayer and two for operating the lance) and six women (*i.e.*, two to prepare spray fluid, two to carry and supply the fluid and two to assist in lifting the 60 feet rubber hose) were employed. 320 trees could be sprayed with 480 gallons of fluid in one day. The particulars of expenditure are given below.

	Rs nP.
Total cost of 16 lb. of DDT 50% WP. and 16 lb. of wettable sulphur (at Rs. 2·28 per lb. of DDT 50% WP. & 0·75 nP. per lb. of wettable sulphur).	49·44
Hire charge for open cart for a day	4·00
Hire charge for sprayer for a day of 8 hours @ 0·37nP. per hour. .	3·00

4—4 F. & A./63

	Rs. nP.
Labour charges : 4 men at Rs. 1·25 each	5·00
6 women at Rs. 0·62 each	3·72
Cost of 1½ gallons of petrol at Rs. 3·19 per gallon	4·79
Proportionate cost of SAE. 30 oil 1½ gallons at Rs. 8 per gallon (Oil to be changed for every 40 working hours. Hence proportionate charge for 8 hours has been taken).	2·00
Total .	71·95

Cost of spraying per tree—Rs. 71·95/320=Rs. 0·23 nP.

II. Hyject Sprayer

Maruti leg-operated Hyject sprayer was used. 80 trees could be sprayed in one day using 160 gallons of fluid. The cost of spraying per tree is given below.

	Rs. nP.
Total cost of 5⅛ lb. in each of DDT 50% WP. & wettable sulphur at the rate mentioned above.	16·48
Labour charges for 2 men & 2 women (rate as above) . . .	3·74
Hire charge for sprayer	1·00
Total .	21·22

Cost of spraying per tree—Rs. 21.22/80=Rs. 0·27 nP.

III. Rocker Sprayer

Addison hand-operated Rocker sprayers were used in this case. 65 trees could be sprayed in one day using 130 gallons of fluid. The cost of spraying is as follows.

	Rs. nP.
Cost of 4⅛ lb. in each of DDT 50% W.P. & wettable sulphur (rate as above).	13·39
Labour charges for 2 men and 2 women	3·74
Hire charge for sprayer for one day	1·00
Total .	18·13

Cost of spraying per tree—Rs. 18.13/65=Rs. 0·28nP.

The result of the observations made is given below :—

Type of Sprayer	Number of trees Sprayed (in a day)	Labour required		Fluid required per tree (in gallons)	Hire and labour charges per tree (in nP.)	Cost of spraying per tree (in nP.)
		Men	Women			
1. Hatsuta power sprayer (2½ H.P.)	320	4	6	1½	7	23
2. Maruti leg-operated Hyject sprayer.	80	2	2	2	6	27
3. Hand operated-Addison Rocker sprayer.	65	2	2	2	6	28

From the data given above it may be noted that power sprayer is the most economical of the appliances. There is a saving in labour and the quantity of fluid and consequently quantity of chemical. In certain places where the labour problem becomes acute due to the coincidence of paddy harvest, the use of power sprayer becomes handy in tiding over the difficulty. Though Thirumal Rao (1953) has stated that the labour charge alone works out to 25nP. per tree, from our observations it comes to only 6 to 7 nP. per tree.

The performance of the Hyject sprayer is better than that of Rocker sprayer as it is easy to negotiate even tall trees and treat larger number of trees. This is in agreement with the observation of Thirumal Rao (1953). However, the quantity of fluid required for spraying largely depends on the age, size and height of the trees in the orchard. In conclusion it may be stated that wherever power sprayer is available it may be used as it is economical and large number of trees can be treated within a short period.

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DISEASES OF CUMIN CROP IN MEHSANA DISTRICT, GUJARAT STATE

By

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The district of Mehsana, in Gujarat State, is the major cumin growing area in India. Nearly thirty-five thousand acres are put under cumin in this district every year. The annual yield from the crop is estimated to be 3 to 3.5 lakh maunds which in terms of money, is worth about 4 to 5 crores of rupees. In addition to Mehsana, the adjoining districts of Kaira and Banaskantha in the same State, Ajmer in Rajasthan and Coimbatore in Madras, also grow cumin on a small scale.

Cumin is grown on light soil which does not retain moisture for a long time and thrives best in a light sandy loam soil and in dry and mild winter. Cumin plants are very susceptible to fungus diseases and excess of moisture due to irrigation, rains or cloudy weather encourages them.

Cultivation of cumin requires experience and expert handling because a little mistake in not putting the seed to proper depth or excess of irrigation at the time of sowing or in subsequent periods may spoil the crop.

Sowing starts in early November and continues till the first week of December. Cow-dung manure is preferred to the chemical fertilizers. After three to four ploughings the fields are levelled and divided into small plots of 4-6 sq. yards each. This division of fields into very small plots helps in regulating the quantity of water to be given in each irrigation. It also facilitates the eradication of weeds without trampling the cumin plants which are very tender. Seed is then broadcasted in each plot at the rate of 15-20 lb. per acre and lightly covered with soil with a rack or a broom. Great care is taken not to allow the seed to go deeper than ½ an inch or so otherwise it results in poor germination.

Four to five light irrigations are required for the crop to mature. The first irrigation is applied immediately after sowing ; the second irrigation is applied after about ten days which helps the seedlings to come up from the soil ; the third is given after a fortnight and fourth and final just when the crop comes to flowering. The fifth watering may be required if the days are hot or if the soil is poor. Plants start flowering within four to six weeks after germination. The crop is ready for harvest in ten to twelve weeks from the time of sowing. The mature plants are about 9″ to 12″ high and umbrella shaped on the top. Harvesting is done by pulling out the ripe plants from the soil. The grains which are in bunches are removed from the stalks by thrashing and winnowing.

The most important limiting factor in the successful cultivation of the crop is the control of the powdery mildew disease which if not checked can take a heavy toll. There are also two other diseases of lesser importance; these are 'blight' and 'wilt'.

The cumin plants are very susceptible to fungus diseases. Powdery mildew, cumin blight and wilt are the three diseases which are of common occurrence and sometimes bring about a total failure of the crop.

Powdery Mildew (*Erysiphe Polygoni* **DC.**)

The disease is locally known as 'Dhaulia'. It appears on the plants at the flowering stage. A silvery white powdery substance first appears at the top on the inflorescence when the plants are about six weeks old and gradually spreads to the lower parts of the plants. At first, the disease appears in small whitish patches which rapidly spread to the entire field. Cloudy weather or rains acclerate the spread of the disease. Setting of grains is greatly hampered, affecting the quantity and quality of the grain. The few grains that are formed get shrivelled and lose aroma. In case of severe infestation, the loss in yield may be 75 to 80 per cent. Similarly, the poor quality of grain may account for loss of 50 to 60 per cent in the price.

Sulphur dusting at 15 to 20 lb. per acre is resorted to by the growers as a preventive measure irrespective of the appearance of the disease and this has proved so effective that the powdery mildew is considered no more a serious threat. If the disease actually appears, a second dusting is done after an interval of 15-20 days. In Mehsana district alone nearly 150 tons of sulphur are consumed every year for cumin dusting. If the symptoms of the disease appear in a field, delaying of irrigation also helps to arrest it to some extent.

Cumin Blight (*Alternaria burnsii*)

Cumin blight locally known as 'Charmi' is the deadliest of the diseases on cumin. In case of severe attack there is a total loss of the crop. Fortunately the disease is not yet widespread.

The symptoms first appear on the stem and lower parts of the plant as brownish spots which rapidly spread on the whole plant; the tips of leaves start turning brownish. The whole plant looks pale and sickly which ultimately dries up and turns blackish brown. The disease first appears in patches which spread rapidly to the entire field. Since the disease appears before flowering there is no grain formation as the plants die away within a few days. In case of severe attack the plants in the entire field die and the whole field has a blighted appearance. Humid conditions due to cloudy weather, rain or excess of irrigation encourage the spread of the diseases. So far no definite and effective remedial measures have been found. However, preliminary observations show that spraying of copper fungicide at the rate of 2 lb. per acre checks the spread of the disease.

Cumin Wilt (*Fusarium oxysporum* var *cumini*)

Wilt is another disease commonly found on the cumin crop. The disease mostly appears in those fields where cumin is grown for three to four years successively in the same fields without any rotation. The plants wither and dry up without any apparent cause.

No chemical treatment has been tried as a preventive measure against the disease. The common practice is that cumin is not grown for more than three years successively in the same field. This practice has been found to be quite effective to check the disease.

EPIDEMIC OUTBREAK OF GRAM CATERPILLAR IN MADHYA PRADESH AND CONTROL OPERATIONS UNDERTAKEN DURING 1958-59

By

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Introduction

The cultivated area is 35,233,000 acres. Gram is an important crop of Madhya Pradesh and is sown over an area of about 4 million acres. In fact it is the second best *Rabi* crop after wheat. Sowing season extends from October to December. In the regions comprising of Indore, Bhopal and Jabalpur, the sowing of gram starts in October while in the Northern areas of the State comprising of the Divisions of Gwalior and parts of Rewa, the sowing starts late in November and extends upto December. The crop also matures at different periods. The crop when sown in October is ready for harvesting in February, but in regions where it is sown late, the crop is ready for harvesting in March—April. The gram crop in the State of Madhya Pradesh is attacked by two important insect pests, *viz.*, cutworms (*Agrotis* sp.) and gram caterpillar, popularly also called gram pod borer (*Heliothis armigera* Hb.).

Nature of Damage

The damage by gram caterpillar occurs in the form of eating of leaves and cutting of shoots, when the crop is young. When in flowers, the young shoots bearing flowers are either cut or eaten. When the pods start forming, the caterpillar bores a hole in the pod and eats the developing grain with the result that only empty shells are left on the plant which turn yellow with the passage of time, shrivel and drop to the ground without any grain in them.

Epidemic Outbreak Gram Caterpillar and Control Operations Undertaken

During the year 1958-59 the first report of attack by this pest was received from the district of Indore in the second week of December, 1958. Reports were subsequently also received from other districts of Indore Division as well as from almost all the important gram growing districts of the Divisions of Bhopal, Jabalpur and Rewa. The Divisions of Raipur and Bilaspur are predominantly paddy growing but reports received indicated that gram was also suffering from the ravages of this pest. In the district of Durg, the damage caused by this pest was so serious that the crop over a large area (about 20,000 acres) was entirely eaten up by the caterpillars. The reports of serious damage were also received from the districts of Hoshangabad and

Narsinghpur The incidence of the pest in other districts was, however, low. The pest was almost absent from all the districts of Gwalior Division. A rough estimate based as a result of the survey undertaken in the districts of Indore, Ujjain, Ratlam, Dhar, Dewas, Shajapur as well as personal discussions held with the extension staff of the Agricultural Department, indicated that the pest was physically present in an area of about 1 million acres (out of estimated 4 million acres sown under gram during 1958-59), but generally speaking the incidence of the pest was low except in the districts of Durg, Hoshangabad and Narsinghpur. .

The problem of gram caterpillar control was chalked out in consultation with the Deputy Director of Agriculture, Indore, Collector, Indore, and the Plant Protection Officer, M.P., Gwalior. A ten point programme was chalked out and necessary instructions for the control of the pest at the earliest and in the quickest possible way were issued to all the Collectors and the Assistant Directors of Agriculture of Indore Division.

The control operations by dusting with 10% BHC were undertaken in almost all the affected districts. In addition to 10% BHC dust, the pest was also controlled by dusting with 5% DDT and 2% aldrin but the area dusted with DDT and aldrin was very small. It is estimated that the total area treated against the pest was about 35,000 to 40,000 acres.

The Central Plant Protection Station, Indore assisted the State Department of Agriculture in the districts of Indore, Dewas, Ujjain, Ratlam, Dhar, Jhabua, Narsinghpur and Durg and about 15,000 acres out of a total of 35,000—40,000 acres were treated with its assistance. The Station loaned 9 power dusters and 174 hand dusters and supplied 71·5 tons of 10% BHC dust. Services of a Technical Assistant, a Junior Technical Assistant and a Care-taker-mechanic were placed at the disposal of the State Department of Agriculture. One vehicle along with a driver was loaned for a period of 47 days. The entire area was treated with ground equipment consisting of hand and power operated dusters. The campaign which was started in the middle of December, 1958 lasted up to the end of February, 1959 in most areas, however, it was suspended by the end of January.

The Effect of Weather on Epidemic

The pest occurs all over the State of Madhya Pradesh and in the past too, reports of minor damage had been received. This year the pest appeared over large areas in the second week of December, 1958 but in most of the districts of Madhya Pradesh, the activity subsided by the middle of January, 1959. The minimum temperature dropped from 57-58°F. (in the first week of January, 1959) to 46°F. on 9th January, 1959. There was cold breeze from 12th-14th January, 1959. This resulted in natural mortality of the caterpillars. The pest also suspended active feeding and took shelter in the cracks and crevices in the soil. Amongst the natural enemies, king crows, sparrows and rosy pastor were found feeding on caterpillars. The result was that

most of the control operations were over by the end of January but in the district of Narsinghpur where about 2 lakhs acres were sown under gram and the crop is usually sown late and also due to the absence of cold wave and other natural enemies, the activity of the pest continued even in February, therefore, the control operations were continued up to the end of February, 1959.

Extent of Damage

In the early sown crop the damage was mainly due to destruction of tender shoots and leaves but, as is well known, such losses are compensated by increased branching. The formation of pods coincided with comparatively low temperatures when the pest became practically inactive. In areas where the crop was sown late, namely, districts of Narsinghpur and Hoshangabad the pest activity continued upto the end of February when the pods were present. It is estimated that losses ranged from 2·5 to 5 per cent over 1 million acres in such areas.

PLANT PROTECTION IN WORLD AGRICULTURE FAIR

By

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The World Agriculture Fair was organised by Bharat Krishak Samaj (Farmer's Forum of India) on a large scale over an area of about 150 acres in which several States, Central Government Departments, Commodity Committees, Commercial Firms etc. and many foreign countries participated. Such an agricultural fair covering almost all the aspects of agriculture was the biggest ever held in India. It lasted from 11th December, 1959 to 29th February, 1960 and being a World Fair attracted people from all walks of life, especially farmers, from different parts of India.

The subject of plant protection being relatively new as compared to other agricultural operations, the need for projecting it in detail at the World Agriculture Fair in a separate pavilion was considered and given shape.

Both the Public and Private Sectors participated in the Pavilion which was organised by the Directorate of Plant Protection, Quarantine and Storage. In the Public Sector the Directorate of Plant Protection, Quarantine and Storage of the Ministry of Food and Agriculture was represented and in the Private Sectors the following Commercial Houses participated:

1. Burmah-Shell Oil Storage & Distributing Co. of India Ltd., New Delhi.
2. Imperial Chemical Industries (India) Private Ltd., New Delhi.
3. Tata Fison Ltd., Bombay.
4. Bharat Pulverising Mills Pvt. Ltd., Bombay.
5. Bayers Agro. Chem. Ltd., Bombay.
6. American Spring & Pressing Works, Bombay.
7. Addison & Co. (Private) Ltd., Madras.

Throughout the Plant Protection Pavilions information about occurrence of pests and diseases in India and methods of their control, availability and application of pesticides and equipment were lucidly exhibited and explained by means of actual specimens, charts, maps, photographs, slides, models, films and demonstrations. The tasteful decoration of the pavilions and the way exhibits were displayed made the subject of plant protection accessible to the common man. All the pavilions soon gained popularity and were thronged by visitors; especially on holidays, it became difficult to manage the crowd. A brief account of the various pavilions and their characteristic features are described below.

Directorate of Plant Protection, Quarantine and Storage

The pavilion was conspicuous by the presence of an Auster Autocar aircraft, spraying and revolving intermittently in the open space in front. The facade of the pavilion had a large fascinating mural painting showing the evolution of plant protection in India which could not be missed by a visitor coming to the fair. Inside the pavilion, the exhibits were displayed in covered and open space, covering 6,000 and 1,000 sq. ft. respectively, at a total cost of Rs. 1,30,000, including construction work, rent of space, preparation of exhibits etc.

The exhibits were arranged in four sections representing four main activities of the Directorate, namely, Plant Protection, Locust Control, Storage Entomology and Plant Quarantine. All the items of exhibits were explained in popular language, both in Hindi and English.

In 'Plant Protection Section', a large range of power and hand-operated application equipment, models of insect pests, actual specimens of pests, diseases and weeds of all India importance and maps giving their distribution and methods of control, photographs, posters, drawings and living specimens of insect and non-insect animal pests of crops, various kinds of pesticides, information about their consumption and production in India and precautions for storing and handling them were on display. Models of crop spraying aeroplane, nozzles and machines for testing nozzle performance (Patternator), hand duster, foot sprayer were also included in the Plant Protection Section.

In the 'Locust Control Section' drawings showing improvements in the techniques of locust control, diorama models, translides and photographs of locust life history and methods of control and maps showing world distribution of different species of locusts, invasion and breeding grounds and outbreaks of desert locust were exhibited. The development of 1949-1955 locust plague was also explained by means of maps.

In the 'Storage Entomology Section' models of improved types of storage structures, storage pests, photographs of damaged stored materials and fumigation under cover by methyl bromide were displayed.

In 'Plant Quarantine Section' photographs of pests and diseases not occurring in India but likely to be introduced, process of examination of imported plants and plant materials, fumigation in vacuum and barges and plant quarantine and fumigation equipment were exhibited.

During the World Agriculture Fair, films of plant protection interest were shown daily in the plant protection pavilion. A convention on plant protection was also organized by the Directorate of Plant Protection, Quarantine and Storage and held in the pavilion of the German Democratic Republic. Prof. Dr. Hey of the Leipzig University spoke on the plant protection in the German Democratic Republic pavilion.

More than 100 plant protection workers of the Central and State Governments and representatives of Commercial Firms attended the convention. Pamphlets, leaflets and posters on plant protection were also distributed free to the public to make them conscious of plant protection and on the spot enquiries relating to plant protection from individuals were attended to. A brochure of 17 pages dealing with Plant Protection in India was brought out by the Directorate for distribution to the public.

During the World Agriculture Fair about 2 lakh persons visited the Directorate's pavilion. For its educative and scientific value the pavilion was awarded a second prize.

Burmah-Shell Oil Storage and Distributing Co.

This was a small pavilion but the activities of the firm were well decorated one. Pesticides marketed by the firm and the spectrum of pests and diseases against which they had proved successful were artistically displayed and illustrated wherever necessary. The pavilion gave an impressive account of locusts and their control. A world map profusely lighted in the centre of the pavilion showing activities of the Company was the focus of attention of every visitor. It was awarded a prize.

Imperial Chemical Industries

This was a small pavilion but the activities of the firm were well represented. Besides the pesticides in which the firm deals, plastic materials were also on the show. A working model of an insect at the entrance of the pavilion was the centre of attraction.

Tata Fison

The pavilion of this firm was a little away from other plant protection pavilions. The exclusive design of the pavilion and the set up of the exhibits which included products of the firms and information about their use were impressive.

Bayers Agro. Chem. Ltd.

The Bayer Crop Protection Pavilion was highlighted by coloured photographs depicting the use of Bayer products (Folidol E605, Agallol and Ceresan) on major crops of India and film shows. A rotating globe inside the pavilion indicated the popularity and world wide use of the firm's products. On Account of its advantageous position and gay decoration, no visitor to the fair could escape having a peep inside.

Bharat Pulverising Mills

In this pavilion a wide range of 'Hexamar' plant protection chemicals of the firm were on display. The pests and diseases against which 'Hexamar' pesticides were used were also fully illustrated.

American spring & Pressing Works

The pavilion of the American Spring & Pressing Works which is a premier manufacturing firm of plant protection equipment in India was decorated with all types of hand-operated dusting and spraying machines, seed treating drums, rat fumigation pumps to suit every body's pocket and requirement. The interest in the pavilion was sustained by practical demonstrations of the machines.

Addison & Co.

This firm had also displayed a good range of hand sprayers, dusters etc. manufactured by it in a simple but tasteful manner.

Visitors who went round all the plant protection pavilions could not but feel the impact of plant protection and its importance in Indian Agriculture. The science of plant protection having advanced beyond measures during the past one decade, never before, perhaps the need for bringing the knowledge of plant protection to the home of the farmers was felt than during the World Agriculture Fair. The farmers from all parts of the country evinced keen interest in plant protection measures against pests and diseases which take a heavy toll of their crops. It is hoped that agricultural fairs will continue to be held in India and plant protection will occupy the same status in the fairs as in the World Agriculture Fair.

A TRIAL ON THE CONTROL OF PADDY STEM BORER BY EMULSION CONCENTRATES.

By

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Introduction

The paddy stem borer (*Schoenobius incertulas* Wlk.) is the most serious pest of paddy causing heavy loss to the cultivators. At a conservative estimate of 10 per cent damage, the annual loss in yield amounts to about a hundred million rupees to the Indian paddy growers. It is distributed throughout the rice growing tracts of tropics and sub-tropics. In India it is found to be more serious in parts of Andhra Pradesh, Assam, Bihar, Maharashtra, Kerala, Madras, Mysore, Orissa and West Bengal. Though the pest occurs throughout the year in South India, it is more active during the second crop season.

Till the close of the Second World War, the methods of control of this pest consisted only of cultural practices like burning of stubbles after harvest, flooding and ploughing the fields, systematic collection and destruction of egg masses in the field and of moths at light traps. These methods served to minimise the intensity of attack but never solved the problem. After the advent of chlorinated hydrocarbons, pesticides like DDT and BHC both as dust and water dispersible powders were tried and found to be fairly effective. Investigations at the Central Rice Research Institute, Cuttack, on the different methods of application of these chemicals showed that dipping of seedlings in 0·20 per cent BHC prior to transplanting, followed by spraying the crop with 0·20 per cent BHC or dusting 5 per cent BHC five times till flowering gave a significant control of stem borer and increased the yield by 32 per cent.

The introduction of emulsion concentrates was another milestone in the history of the pesticides. The plant protection workers found insecticides like endrin, parathion and diazinon to be more potent and penetrating. Trials to find out the most effective insecticides and optimum dose for the control of the paddy stem borer were undertaken by many workers. Israel and Vedamoorthy (1954) found irrigation with parathion at 0·1 per cent periodically till flowering gave almost complete control of the paddy stem borer. Ananthanarayanan *et al* (1955) recommended 2 to 3 rounds of parathion spraying coinciding with mass emergence of moths. Abraham and Santhanaraman (1959) have reported that 2 rounds of spraying with endrin (0·02 per cent) or parathion (·025 per cent) once a fortnight after transplanting and another at the shot blade stage have given promising results.

The Central Plant Protection Station at Tiruchirapalli conducted an observational trial in 1959-60 and a replicated trial in 1960-61 in the village of Nachikurichi to study the comparative efficacy of some emulsified concentrates. The results are furnished in this paper.

Material and Methods

During the year 1959-60, a trial of three popular insecticides, *viz.* parathion, endrin and diazinon at 6 oz. (0·0375 per cent), 1 lb. (0·04 per cent) and 1 lb. (0·04 per cent) per acre respectively was conducted. The results indicated that parathion and endrin were more effective than diazinon from the insecticidal and yield points of view.

During the year 1960-61, only two insecticides *viz.*, parathion at 4 oz. in 50 gallons of water (0·025 per cent) per acre and 6 oz. in 50 gallon of water (0·0375 per cent) per acre and endrin at 12 oz. in 50 gallons of water (0·03 per cent) and 16 oz. in 50 gallons of water (0·04 per cent) per acre were tried in a randomised replicated trial comprising 3 blocks of 5 plots each measuring 5 cents. Two sprayings, one a fortnight after transplanting and another at the shot blade stage were given. The timings were so chosen as to coincide with the maximum incidence of the pest. Spraying was done with knapsack compression sprayers using 2½ gallons of spray liquid for each plot of 5 cent *i.e.*, 50 gallons per acre. The trial was conducted on a second crop long duration paddy, B.C.P. 1, popularly known as "Kudiraival" which is one of the most susceptible varieties to this pest. Japanese method of cultivation was adopted with planting in lines 10 inches apart.

Five 2-feet square samples of areas were examined at random in each plot and counts of the infested tillers and total number of tillers were recorded as detailed below. In all, 75 such samples were taken for each count. Initial count of the tillers affected by the stem borer just before the first spraying was taken a fortnight after transplanting (on 11-11-60). Second count of the tillers affected by the stem borer was taken a fortnight after first spraying (on 26-11-60). Third count of tillers affected by stem borer was taken just before second spraying at the shot blade stage (on 29-12-60). Count of the chaffy white earheads due to the stem borer was taken 25 days before harvest (on 25-1-61). Final yield of grain in each plot was recorded (on 19-2-61). (Results are given in the tables I, II & III.)

Conclusion

The incidence of the stem borer attack was found to be minimum in the plots treated with endrin at 12 oz. in 50 gallons of water (0·03 per cent) per acre and parathion at 6 oz. in 50 gallons of water (0·0375 per cent) per acre. Considering the percentage of the tillers affected, the treatments are significant at 5 per cent level and all the treatments are superior to control, there being no significant difference among themselves. Though the analysis of yield data does not reveal any significant difference, the plot treated with parathion at 6 oz. in 50 gallons of water (0·0375 per cent) per acre has given the maximum yield of 2,600 lb. per acre, the next best being the plot treated with endrin at 16 oz. in 50 gallons of water (0·04 per cent) per acre, showing an increased yield of 450 lb. and 283 lb. per acre respectively over the control plot yield of 2,150 lb. per acre. As regards the economics of spraying, the cost of treatment per acre for 2 sprayings at full cost of insecticides, hire charges for equipment and labour charges works out at Rs.

19·40 nP. and Rs. 23·20 nP. for parathion at 6 oz. in 50 gallons of water (0·0375 per cent) per acre and endirn at 16 oz. in 50 gallons of water (0·04 per cent), leaving a net extra profit of Rs. 52·60 nP. and Rs. 22·08 per acre respectively (Table IV).

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TABLE I

Statement showing average percentage of incidence of stem borer attack as indicated by dead hearts

Plot	Total No. of tillers	Stem borer affected tillers	Percentage of incidence
1	2	3	4
First count on 11-11-60 *just before first spraying*			
Parathion 4 oz. per acre (0·025%)	403	18	4·4
Parathion 6 oz. per acre (0·037%)	528	38	7·2
Endrin 12 oz. per acre (0·03%)	477	18	3·8
Endrin 16 oz. per acre (0·04%)	409	26	6·3
Control	470	23	4·9
Second count on 26-11-60 *a fortnight after spraying*			
Parathion 4 oz. per acre (0·025%)	418	19	4·5
Parathion 6 oz. per acre (0·037%)	447	20	4·4
Endrin 12 oz. per acre (0·03%)	463	24	5·1
Endrin 16 oz. per acre (0·04%)	448	21	4·6
Control	415	21	3·9

1	2	3	4
Third Count on 29-12-60 just before 2nd Spraying			
Parathion 4 oz. per acre (0·025%)	730	23	3·1
Parathion 6 oz. per acre (0·037%)	750	23	3·1
Endrin 12 oz. per acre (0·03%)	739	23	3·1
Endrin 16 oz. per acre (0·04%)	710	22	3·1
Control	698	27	3·8

TABLE 2

Statement showing the incidence of paddy stem borer as indicated by white chaffy earheads on 25-1-61

Plot	Total No. of earheads	Chaffy earheads	Percentage of incidence
Parathion 4 oz. per acre (0·025%)	230	2·7	·1
Parathion 6 oz. per acre (0·037%)	245	1·7	0·7
Endrin 12 oz. per acre (0·03%)	251	1·7	0·6
Endrin 16 oz. per acre (0·04%)	228	2·7	1·03
Control	250	7·0	2·83

TABLE 3

Statement showing the yield analysis of experimental plots and acre yields

Treatment	Average yield in 5 cent plots	Acre yield	Percentage of increased yield over the control
	lb.	lb.	
Parathion 4 oz. per acre (0·025%)	109·33	2,200	2·32
Parathion 6 oz. per acre (0·037%)	130·00	2,600	20·93
Endrin 12 oz. per acre (0·03%)	114·16	2,283	6·18
Endrin 16 oz. per acre (0·04%)	121·66	2,433	13·16
Control	107·50	2,150	

TABLE 4

Economics of Control measures

Treatment	Cost of treatment per acre for 2 rounds including labour charges	Increased yield of paddy per acre over the control	Approx. value of increased yield	Net gain per acre
	Rs. P.	lb.	Rs. P.	Loss
Parathion 4 oz. per acre	14·28	50	8·00	6·28
Parathion 6 oz. per acre	19·40	450	72·00	52·60
Endrin 12 oz. per acre	18·40	133	21·28	2·88
Endrin 16 oz. per acre	23·20	283	45·28	22·08

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VARIATION IN THE TOXICITY OF BENZENE HEXACHLORIDE IN FIELD

By

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The same stock of 10% gamma-BHC when dusted against the desert locust at different times has been reported by the field staff to vary in the toxicity. Potter and Gillham (1946) as well as some other workers have showed that temperature has an effect on mortality due to insecticide. Gosswald (1933) concluded that any given species was most resistant at its specific vital optimum temperature.Thalenhorst (1937), Yarwood (1943) and Parkin (1944) reported an increase in toxicity with rise in temperature. The humidity factor was regarded to be practically of no significance, though in case of toxic films, the effect of humidity had acted as one of the important factors. All these experiments were performed by the different workers under the constant controlled conditions in the laboratory. In the field the atmospheric temperature and relative humidity change in a particular pattern as the day advances. It was, therefore, considered that the toxicity of BHC would also vary during different periods of the day. The author, therefore, conducted some field trials with 10% BHC dusting powder at 20 lb. per acre against the fifth stage hoppers of the desert locust (*Schistocerca gregaria* Forsk.) in Rajastan State of India.

Three field trials, with three replications of each, were started at 03·00 hours, 08·45 hours and 13·00 hours, respectively. The temperature and relative humidity records were maintained throughout the period of observations till a complete kill was recorded. The fifth stage hoppers were present mostly on bushes. The infested plots were surrounded with a small trench so as not to allow the hoppers to escape. Small manually-operated duster was used for dusting the infested plots. The results obtained were as follows :—

Trials started at 03·00 *hours.*—At the time of starting the experiment, the atmospheric temperature and relative humidity were 77°F and 91% respectively. The mortality was very slow within first two and a half hours and the total kill recorded during this period was 23·8%. As the temperature increased to 84°F and the relative humidity decreased to 71%, between 6 A.M. and 6·30 A.M. the mortality rate increased perceptibly and 65% of the kill was recorded within the next one hour. As the day advanced, it became cloudy and there was some drizzling. The temperature of the atmosphere fell to 80°F and the R.H. rose to 91% during the subsequent hours. The remaining 11·2% mortality was recorded in subsequent 33½ hours. The slow mortality was attributed to drizzling and rain during this period.

Trial started at 08·45 *hours.*—The atmospheric temperature and the R.H. at that time were 84°F and 75% respectively. There was a gradual rise in temperature from 84°F to 93°F and fall in R.H. from 75% to 55% during subsequent 2¼ hours. The complete kill (100% mortality) occurred within 2½ hours.

Trial started at 13·00 *hours.*—The atmospheric temperature and the R.H. at that time were 98°F and 51% respectively. The temperature and the R. H. remained more or less constant during next four hours. The complete kill was recorded in two hours, though majority of the hoppers died within the first hour.

In the field, the dusting of settled swarms of desert locusts with 10% BHC is generally done at night or early in the morning. In that case, the kill of dusted locusts will be delayed till sufficient rise of the atmospheric temperature takes place due to the sunrise. Observations made in the desert areas of Rajasthan confirm this when, a yellow settled locust swarm was dusted during night hours on 17/18-10-1954. The kill was only 15% upto 07·00 hours on 18-10-1954. As the sunshine appeared, complete kill was recorded in the next one and a half hours presumably due to increase in toxicity of BHC.

It is generally recommended that dusting should be done early in the morning or late in the evening so that the powder sticks well on the body of the insects due to high percentage of humidity in the atmosphere. From the third observation above, it is now concluded that dusting done during the noon gives the quickest kill due to the high temperature though the R.H. is the lowest. This finding will be a great help in the locust control, because at noon, hopper bands of locusts congregate in small bushes or in the shady places and if dusting with BHC is done at that time, control efficiency will be double and economical, firstly, because of the high temperature the kill will be quicker, secondly, the smaller space occupied by the hopper bands, will require less insecticide.

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INTERCEPTION OF *EUZOPHERA PUNICAEELLA* MOORE ON FRUITS OF *PUNICA GRANATUM* FROM AFGHANISTAN

BY

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Consequent on the decision of Government of India to allow importation of fruits and vegetables by air from Afghanistan, the Directorate of Plant Protection, Quarantine & Storage established on 1st August, 1954, a Fumigation Station at Amritsar Airport for their disinfestation by fumigation of imported fruits and vegetables so as to eliminate the risk of introduction of exotic insect pests. Through examination of these imported fruits, the author intercepted caterpillars of *Euzophera punicaeella* Moore on pomegranates on 27-9-1954. Subsequent examination of these imported pomegranates at Attari Border and at Amritsar Airport showed that the incidence of these caterpillars was more in the furits popularly known as *Anar Kandhari* which are big with red soft skin and blood red seeds than in the variety popularly called *Anar Bedana* which is small in size with yellowish brown tough skin and pink seeds. According to Janjua (1942), however, the attack is more severe on the seedless (*Bedana*) variety than on the *Kandhari, Jalari* and *Mitha* varieties, as the skin is tender in the former case and the larvae can easily bore into the fruit. The data collected on the interception of this pest from the last week of September, 1954 to December, 1954, indicated that the incidence of infestation was consistantly more in *Anar Kandhari* than in *Anar Bedana;* the highest intensity of infestation in fruits was upto 6 per cent. Generally grown up and prepupal caterpillars are intercepted up to the end of October and the percentage of infestation decreases upto the middle of November from whence small caterpillars of the next generation start coming with the fruits. According to Janjua (1942) the pest in Baluchistan has 4 generations in the year, the last overwintering in the prepupal stage. The young caterpillars are whitish in colour with light brown heads. But as they grow to prepupal stages, they become pinkish brown. Fully grown caterpillar measures about 3/4″ in length.

Prepupal caterpillars show migratory instinct and move about in search of suitable places for pupation. Very frequently these prepupal caterpillars are found crawling out from the dealwood boxes containing fruits. In the laboratory they pupated at the bottom of the glass jars, and sometimes on the muslin tied to the mouth of the jars. The caterpillar secretes a thin silken cocoon before pupation. The pupal period averages about a week.

It has been observed that the entrance holes of these caterpillars are more at the stalk end of the fruit than at the sides and front end. Some of the holes are found plugged with their excretion. The caterpillars work their way through the testa and then into the seeds. Sometime they pass through the fruit, reach the clay-cup and pupate there.

When once the fruits are damaged by the caterpillars, sooty mould starts infesting them. Such damaged fruits rot quickly in storage and have very little commercial value.

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A SERIOUS PEST ON FRUITS OF *ZIZYPHUS JUJUBA*

BY

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Zizyphus jujuba is one of the important fruits common in many parts of India. The grafted variety is reported to extend over 10,000 acres, in States of Bihar, Maharashtra, Gujarat, Assam, Andhra Pradesh, Madras and West Bengal. In Andhra Pradesh alone the area is about 1,000 acres. Much of the area under the fruit trees is unaccounted because it grows in forests, waste lands etc. and accordingly many undefined varieties exist which can easily be differentiated by shape, size and colour of the fruits.

The trees are generally free from diseases but its fruits and leaves are attacked by many kinds of insect pests. Khare (1923) has listed the various pests. Ayyar (1940) has listed the fruit boring capterpillar *Meridarches seyrodes* M. and fruit fly *Carpomyia vesuviana* B. as the important insect pests.

The author had an occasion to see in Andhra Pradesh in September 1954, extensive damage done to fruits in orchards, which could not be attributed to any of the commonly listed major pests. More than 30 per cent of the trees were affected and 40 to 50 per cent of the fruits were damaged. On the close examination of the fruits, the larvae which were later identified as that of *Aubeus himalayanus* Voss were recovered in good numbers. The collected larvae were bred and it was found that it takes 16-18 days to complete its life cycle. The larval, pupal and adult stages were seen in the tender and turgid *ber* fruits. This weevil is seen from the month of September onwards till *ber* fruits mature.

The only record of this insect in India is from Kulu (Voss 1944), in the Himalayas at the height of 3,600 ft. This weevil has not been so far recorded from south India and more so as a pest in the wild *ber* fruits grown in orchards. This is the first record of weevil pest on *ber* fruits in India.

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INTERCEPTION OF A SPECIES *MACROPHOMA* ON IMPORTED PROPAGATING MATERIAL OF CITRUS

BY

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A species of *Macrophoma* on citrus, hitherto not known to occur in India, was intercepted at the Plant Quarantine & Fumigation Station, Bombay. During September, 1951 a consignment of citrus budwood cuttings was received at Bombay from Paris by air. The source of these cuttings was the Central Station at Faulaya, French Guinea, of the Institute Des Fruits et Agrumes Coloniaux, Rue due general clergerie. Out of a total of 36 bundles of different varieties of citrus budwood received for inspection at this Station, the plant material in one bundle was diseased. Since the consignment was not accompanied by a phytosanitary certificate as required under rules of the Destructive Insects and Pests Act, 1914, and in view of the fact that the plant material revealed the presence of a serious and apparently new disease, the consignment was destroyed.

All the five cuttings in one bundle were covered with numerous pycnidia, which varied from small, brown, immature to large, fully mature, black or carbonaceous ones. These were globose, more or less sunken in the substratum, ostiolate, tending to be erumpent on maturity. Conidiophores were simple, short, filiform and hyaline. Conidia or pycnidiospores were borne singly; they were large, mostly elliptical, sometimes oval, unappendaged, hyaline, nonseptate or continuous, with somewhat granular contents, measuring 24.2 to 30.8 microns by 11.8 to 14.3 microns (mean 26.84 × 13.24 microns).

Five species of *Macrophoma* have been recorded on citrus, namely *M. citri* Celotti on twigs of *Citrus triptera* Desf. from Montpellier, France (4) ; *M. kuwatsukaii* Hara causing storage rot of orange from China (6) ; *M. aurantia* Scalia on leaves of *Citrus sinensis* L. from Italy (2) : *M. Mantegazziana* (Penz.) Berl. & Vogl. on leaves of *Citrus* sp. from Brazil (1) and Ceylon (2) and *M. paraphysata* Speg. on dead branches of orange from Paraguay (5).

TABLE

Species	Host and Parts affected	Spore dimensions in microns
M. mantegazziana . .	Mostly on leaves, rarely on branches of *Citrus medica* and *Citrus* sp.	19 to 22 × 4 to 5
M. aurantia . . .	Leaves of *Citrus aurantia* .	21 to 33 × 7·5 to 9
M. citri . . .	Branches of *Citrus triptera*(*Poncirus trifoliata*)	25 to 28 × 8 to 10
M. paraphysata . .	Branches of orange . .	18 to 26 × 12 to 16
Macrophoma sp. intercepted at Bombay.	Cuttings of *Citrus* sp. . .	24·2 to 30·8 × 11·8 to 14·3 (mean 26·84 × 13·24)

A comparison of spore dimensions of the known species of *Macrophoma* on citrus (see Table) shows that the fungus intercepted at Bombay, although not identical with *M. paraphysata,* approaches it more closely than any of the other species mentioned therein. In view of these considerations the intercepted fungus is regarded as a variety of *Macrophoma paraphysata.*

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CONTROL OF *ACANTHOSPERMUM HISPIDUM* WITH WEEDICIDES

Acanthospermum hispidum (Family Compositae), an annual, is an important weed in the dry and waste lands. This weed was introduced into India from South America, some years ago. The weed is very harmful to crops because of its surface feeding nature and gregarious habits. The plant is capable of spreading rapidly as the achenes are easily dispersed by the agency of animals and human beings. The plants are so very gregarious and numerous that large number of spinous achenes produced are a constant source of annoyance to bare-footed pedestrians, cattle and sheep. In Telangana, its spread has been very rapid, specially during and after the Second World War. It occupies many acres of cultivable land and grows so fast and luxuriantly that crops and even fodder grasses have little chance of survival. Fallow lands are more easily covered by this weed.

Trials with different weedicides were made against this weed at Himayatsagar when the writer was employed in the agricultural department of the Hyderabad State. A fallow land of about two acres, where the weed was growing luxuriantly, was selected for the trials. The treatments given were as follows :—

Fernoxone

It is sodium salt of 2,4-D, containing 80 per cent acid equivalent and was used at the rate of $\frac{1}{4}$, $\frac{1}{2}$, 1 and 2 oz. per gallon of water.

Atlacid

It is a greyish powder containing chlorates and has no serious fire hazards as in the case of straight sodium chlorate. Its use is limited to places where crops are not grown. It was used at the rate of $\frac{1}{4}$ and $\frac{1}{2}$ oz. per gallon of water.

Extar 'A'

This weedicide is based on Dinitro-orthocresol, containing 40% active ingredient. It is used against broad-leaved weeds in cereal crops. It was applied at the rate of $\frac{1}{4}$ and $\frac{1}{2}$ oz. per gallon of water.

Coronox

This is an amine salt of 2, 4-D and is marketed in the liquid form. It is especially effective against water hyacinth. It was used at the rate of 45 and 90 cc. per gallon of water.

The area under each treatment was 1/40 of an acre. The treatments were replicated thrice. About 30 gallons of spray material was

used per acre. A control was maintained for each treatment. The weedicides were applied to grown-up plants reaching maturity. Observations on the effect of weedicides on the weed were taken 1, 3 and 10 days after the treatment.

Except Atlacid at the rate of $\frac{1}{2}$ oz. per gallon of water, the other weedicides had no immediate effect on the weed; Fernoxone at the rate of 2 oz. per gallon, Extar 'A' at the rate of $\frac{1}{2}$ oz. per gallon and Coronox at the rate of 90 cc. per gallon had slight effect on the weed on the first day after treatment. Atlacid and Extar 'A' produced pronounced drying effect three days after the treatment. Fernoxone and Coronox at higher concentrations had a good effect on the weed but their action was very slow. In Atlacid treated plots, weeds completely dried up. Fernoxone at the rate of $\frac{1}{4}$ oz. per gallon and Extar 'A' at the rate of $\frac{1}{4}$ oz. per gallon had no effect on the weed even 15 days after treatment.

Repeated applications of weedicides may not be necessary as the weed can be killed with one application alone at the effective dosage. Atlacid should not be used on crops and Extar 'A' should be used with care.

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